GEOLOGICAL SURVEY
OF
ALABAMA.

EUGENE ALLEN SMITH, PH. D., STATE GEOLOGIST.

BULLETIN NO. 5.

PART I.

A PRELIMINARY REPORT ON THE

UPPER GOLD BELT OF ALABAMA,

in the Counties of Cleburne, Randolph, Clay, Talladega, Elmore, Coosa and Tallapoosa.

BY

WM. M. BREWER, Assistant.

PART II.

Supplementary Notes on the Most Important Varieties of the Metamorphic or Crystalline Rocks of Alabama, their Composition, Distribution, Structure, and Microscopic Characters. By EUGENE A. SMITH, GEO. W. HAWES, J. M. CLEMENTS AND A. H. BROOKS.

WITH THREE PLATES.

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rocks examined under the microscope, have yielded more abundant and at the same time more certain and definite information concerning the origin and history of these rocks together with their mineral contents, than almost all other methods of investigation combined. If we are to keep at all in line with the progress of the world in the study and presentation of our natural resources, it will not do to neglect any of the sources of information which modern methods of scientific investigation place at our disposal.

We are therefore to be accounted fortunate in having the notes of Dr. Clements and Mr. Brooks upon some of our typical rock varieties, and our obligations to these gentlemen, and to the authorities of the United States Geological Survey, with which Mr. Brooks is connected, are not lessened by the circumstance that these notes have been contributed without cost to our State Survey.

Very respectfully,

EUGENE A. SMITH,

University of Alabama, June 15, 1896.

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Part II.

LETTER OF TRANSMITTAL.

To Dr. Eugene A. Smith,
State Geologist:

DEAR SIR:—With this I hand you my report on the gold occurrences of the Upper Belt of the Alabama Gold Regions.

The field work which furnishes the material for the greater part of these notes was done during the summers of 1893–4. Since that time, however, I have had occasion to revisit several parts of the field where active work of prospecting or mining was being carried on, and to revise the notes, and bring them up to date. This will explain the lack of compactness or unity in some of the descriptions, especially of the Pinetucky, Idaho and Arbacoochee Districts.

In describing the gold deposits, I have in this report, commonly spoken of them as bedded veins, stratified deposits, etc., and have made use of the terms stratification, strata, and beds, in connection with the rocks of the country. These are the terms most naturally suggested by the general appearances, and they will perhaps be better understood by the majority of those who may make use of this report.

I am aware, however, of the fact that the structure of these crystalline rocks may in many cases have no connection with stratification, since the fully crystalline schists are now generally considered to have been derived by metamorphism from massive igneous rocks, and even in the rocks of sedimentary origin—like the Talladega slates—the planes of cleavage may not necessarily be the planes of original stratification.

With this explanation I trust that my use of the terms

SILVER HILL BELT.

TOPOGRAPHICAL AND GEOLOGICAL FEATURES.

The name above given was taken from the mine situated in the hill locally known by that name, in Secs. 16 and 17, T. 20, R. 22; and about 1½ miles south of that prominent feature of the landscape, mentioned both by Prof. Tuomey in his report dated 1858, and Dr. Phillips in his, dated 1892, and referred to by them as the "Devil's Back-bone."

The fact that this is the most south-easterly of any belt or series of leads of gold-bearing ore in the State, is one of my reasons for taking it up first in my report.

In both the reports above referred to, no particular mention is made of the extent longitudinally of this bold ridge, or of the location of its south-western extremity which I found to be in Sec. 18, T. 19, R. 21 in Elmore county, about 2 miles north-east of Eclectic P. O. There it is that the 'Talladega' semi-crystalline slate is first seen as one travels north-east from Wetumpka; and there also is the point where the ridge, which extends as a bold feature of the landscape across this section of the State, and into Georgia, first assumes definite outlines.

The name of "Devil's Back-bone" does not receive local recognition in Elmore county, nor does the ridge assume its full proportions so far as height and barrenness are concerned until it crosses into Tallapoosa county at the extreme north-east corner of Elmore county.

The strata of semi-crystalline slate and quartzite which compose this ridge have their lines of strike north-east and south-west with a south-east dip, and consequently the ridge itself possesses the same trend, maintaining its continuity persistently in this portion of Elmore county,

except where it is cut through by Channahatchee and Kielijah creeks.

MINING OPERATIONS.

Channahatchee Creek and Peru Branch.

While gold has been discovered immediately on the crest of this ridge in Tallapoosa county, yet so far as at present known, such is not the case in Elmore. Limited prospecting work has been done in years past on Channahatchee creek,but such was abandoned, almost beyond the recollection of the oldest settlers;and despite recent excitements on the north-eastern side of the river on this belt of semi-crystalline slate, in which several gold-bearing ore bodies have been discovered, no one has faith enough to prospect this ridge on the south-western side.

This "Devil's Back-bone" ridge crosses the Tallapoosa river in Sec. 32, T. 21, R. 22, and preserving its general characteristics in a north-easterly course, crosses the Columbus and Western Railroad at Jackson's Gap Station; and again crosses the Tallapoosa river near the northern borders of the Horse Shoe Bend in which is located the old battle ground where Gen. Jackson routed the Indians.

The "New Yorker Shoals" also cross the river in the same vicinity in Sec. 24, T. 23, R. 23 E. or to locate the crossing exactly, this range line follows the river which at this point runs north for a short distance. The "Devil's Back-bone," while its course can be readily traced to the north-east, across the Tallapoosa for the third time, near Denny's ferry in the north-western corner of Chambers county, thence across Randolph county and into Georgia, does not form as prominent a land mark as in the vicinity of the gold mining district in Tallapoosa county. The semi-crystalline Talladega slates and quartzites form the ridge and its flanks throughout this entire distance, and many of the occur-

rences of gold-bearing quartz are associated with these rocks.

Besides the old workings referred to already, on Channahatchee Chreek, I was also informed of other prospecting which had been done in the past in Elmore county in this vicinity on Peru Branch. But it is impossible to get any thoroughly reliable information as to the results of this early work, which was carried on in the most primitive methods of gold mining, and only the ore near the surface which was thoroughly oxidised was treated, together with any placer gravel beds that occurred on the creeks and branches.

Silver Hill, Blue Hill, and Northeastward.

One fact is noticeable throughout this Silver Hill belt; from beyond Blue Hill, which is located in Sec. 33, T. 21, R. 22, in a north-easterly direction, no prospecting has been done anywhere on the bold and prominent quartz outcroppings, which rise above the apex of the ridge proper, in many places, to the height of 10 or 12 feet. These outcroppings are composed of a sugary quartz, many samples from which, I found, panned colors; as also was ascertained by Dr. Phillips.* The reason why no work has been carried on is obvious, for except where this ridge is cross cut by the river and creeks, to obtain the water supply necessary for conducting mining and milling operations would require the investment of large capital to render it available.

For this reason, as well as because the ore is invariably richer, all mining, except in the immediate vicinity of Blue and Silver Hills, has been carried on in the less prominent ridges in the same country rock, which parallel the Back-bone proper.

In traveling to the north-east from Blue Hill I found

*Bulletin No. 3, Alabama Geological Survey.

that the gold-bearing quartz and graphitic slates were not as closely associated as is the case at Blue and Gregory Hills (both in the same land section), where the two become a conglomerated mass so intermixed and irregular in structure that it is impossible to separate the one from the other, and the entire hill sides are quarried down and sent to the mill. This product from the mines was yielding, at the time of my visit, about $2.00 a ton, or rather that amount was saved. I am of opinion though, after panning several average samples, that at least double this amount would be saved, were some process devised for eliminating the graphite before amalgamation was attempted. Apart from this graphite the ore which I saw mined at Blue Hill had no refractory characteristics, but in the other mines in the vicinity the ore is heavily sulphuretted, even at shallow depth. A sample of ore from the Nichols opening, near Blue Hill, gave on analysis $8.66 per ton. This ore has very little graphite. The Devil's Backbone, and indeed the entire belt of semi-crystaline slates are partially or entirely cross cut at irregular intervals by the waters of Big Sandy Creek, at Pace's mill, Sec. 15, T. 21, R. 22 E.; by Manoa Creek, Sec. 34, T. 22, R. 22 E.; by Jackson's Gap cut on the Columbus and Western Railroad, Sec. 13, T. 22, R. 22 E.; by the Tallapoosa River at Horseshoe Bend, already referred to; by Jay Bird Creek between Jackson's Gap and the Horseshoe Bend, Sec. 33, T. 22, R. 23 E.; by Galloway Creek and Hardnett's Mill Creek, two miles south of Daviston P. O. near the northeast corner of Tallapoosa county; by the Tallapoosa River at Denny's Ferry in Chambers county, and by some of the head-waters of High Pine Creek in Randolph county; as well as by the headwaters of Wehadkee Creek in the same county near the State line.

Jackson's Gap, which I have referred to as cross cutting the Backbone, affords a good opportunity for studying

the formation and structure of this ridge. In a deep cut made by the railroad, about 25 feet in depth and 400 in length, I noticed that the strata of slate and quartz have been twisted and folded into snake-like contortions, having no regularity in dip or thickness, as depth is attained. The stringers of quartz are interpolated between the slates, without any conformity, and having a lenticular or kidney-like structure. A thick outcrop at the surface in several places pinches out a few feet below; while in other instances although no outcrop occurs at the surface, yet 10 or 20 feet below kidneys of quartz are seen imbedded between the slates in masses and pockets; in one case, attaining a thickness of several feet at the bottom or floor of the cut, and this body of quartz extended below the bottom or floor of the cut.

From the formation in this cut, also from the fact that the Bonner-Terrell and Gunn properties located on a parallel ridge possess the same structure, I am inclined to the opinion that gold mining in this vicinity would prove quite uncertain.

In width, I find that this belt of semi-crystalline slate with the associated gold-bearing ore, is more extensive than is generally supposed. While the main lead apparently outcrops along the crest of the Devil's Backbone, I observed outcrops and old workings, at many points along the line of strike of the belt, more than a mile and a half to the south-east; but the Devil's Backbone apparently marks the line of the northwestern border; beyond which you pass at once into gneiss and mica-schist.

Bonner-Terrell Mine and Vicinity.—In the vicinity of Jackson's Gap there are only two known evidences of gold bearing ore. These are the Bonner-Terrell and Preacher Gunn properties. The first named is located on Sec. 19, T. 12, R. 23. It was worked to some extent, as the old openings demonstrate, some years since, and a

stamp mill was run on the ore; but for some reasons the old openings were abandoned and allowed to cave in, the mill was torn down and moved away, and to-day it is impossible to form any idea from an examination as to the extent or value of the ore.

The last named is located on Sec. 30, T. 22, R. 23. Here only shallow prospecting has been attempted. Some samples from a narrow seam of quartz bedded conformably with the country rock panned quite richly, but the formation is apparently similar to that at Jackson's Gap with regard to structure, and the work is entirely insufficient to warrant any opinion regarding the prospect; beyond the statement that some of the quartz carries gold. At another point on this same property a shallow pit exposes a seam of ore about 18 in. or 2 feet in thickness. This however does not pan as richly as the thin streak, while the same facts exist as to work, etc.

Eagle Creek Gold Mining District.

This is the local name given to that portion of the Silver Hill belt which lies adjacent to and in the vicinity of the Horseshoe Bend of the Tallapoosa River, and the New Yorker Shoals. The name is taken from that of a creek which empties into the Tallapoosa River on the southeast side near the New Yorker Shoals.

This district on both sides of the river was quite extensively worked several years ago, and a stamp mill, or as it was then called, a "pounding mill," was operated on ore mined from near the surface; but work was abandoned when sulphurets were encountered. Since then the old openings have been allowed to cave in and fill up with debris, so that it was with difficulty I could enter the same, and examine the ore bodies.

These occurrences were not on the Devil's Backbone ridge proper, or *Sheep Hill*, as this portion of the ridge

is locally called, but on ridges having their trend nearly parallel with the main ridge, and located about one mile to the southward of it.

Jennings', S. W. Sec. 26, T. 23, R. 23 E.—This property is the southwestern-most in this district on which a body of gold-bearing ore has been discovered and prospected to some extent. There appears a slight change in the character of the country rock; which has the appearance of a hydro-mica schist rather than the semi-crystalline "Talladega" slate. The ore is a somewhat sugary decomposed quartz, and the body I examined was a seam some 6 to 8 inches in thickness in apparent conformity with the country rock. The openings in this property were all shallow prospect pits, and beyond the fact that it panned at about the rate of $3.00 or $4.00 a ton, but little could be determined as to structure or permanency.

Tapley, S. E. Sec. 26, T. 23, R. 23, E.—This property adjoins the Jennings, and is apparently an extension of that ore body. The openings were more numerous and extensive. In fact in one place ore had been mined a depth of 50 feet, but so long ago that the timbering had rotted and the openings were inaccessible. Some of the ore remained on the old dumps. This was a whitish flinty quartz, highly sulphuretted, and quite undesirable for treatment by amalgamation. Several tons of ore from this property had been treated in the mill already referred to, but no reliable information could be obtained as to the results.

Where I was able to see this ore body I found it showed about the same thickness as on the Jennings property, with its line of strike N. E. and S. W. and dipping at an angle of about 45 deg. slightly E. of S. There are also several thin stringers of a bluish colored, hard sulphuretted quartz on these properties; all of

which show gold by panning, so far as I was able to test them.

Hammock, S. W. Sec. 24, T. 23, R. 23, E.—This property was mined on about 12 years since, and the mill above referred to was then in operation on a branch which flows through the property. Nothing now remains to mark the spot where the mill stood except some rotten timbers, and an old ore dump. It is claimed that some of the ore from this property milled $30.00 a ton in free gold, but a sample I took from the dump, assayed only $5.70 a ton in gold. The ore resembles the Tapley; being a highly sulphuretted hard quartz. The sample I took was, as near as I could judge, without systematic sampling, a fair average of a few tons which still remained on the dump. Milling and mining were suspended, it is claimed, because the ore was too highly sulphuretted to work profitably by ordinary amalgamation. No information whatever could be gathered from the old openings.

Greer, S. E. Sec. 24, T. 23, R. 23. E.—From the Hammock property I traced the same lead of quartz by the outcrop, to the Greer, which extends to the Mule-shoe Bend of the Tallapoosa River, situated partially in the eastern portion of this same section. The ore here has the same general characteristics as in all the openings, as well as in the outcroppings, through this district, and apparently is of about the same relative value. From the best information I could obtain, ore from all these properties in this district on this side of the river was milled in the Hammock mill some 12 years since; but no work has been done recently, except that some of the shallow pits were partially cleaned out to enable me to see the ore body, which has the structure of a bedded vein, in the hydro-mica schist country rock, conformably with the general formation and having its line of strike N. E. and

S. W., and dipping at an angle of about 45 deg. towards S. E.

Crossing the river at the Griffin ferry in Sec. 24, T. 23, R. 23 E., I continued my work of tracing this gold lead or belt by actually following along the line of strike of the formation towards the Georgia-Alabama State line.

In this I found some difficulty, because except in the vicinity of the river, the outcrop had lost some of the bold and prominent features it possessed towards the S. W. As nearly as I could trace it by the country rock, which along the south-eastern border of the belt still maintained those characteristics which led me to classify it as a hydro-mica schist, but towards the north-western border preserved the appearance typical of the "Talladega" semi-crystalline slate, I found that the belt continued along the summit and sides of a well defined ridge. Though not as prominent a land-mark as the Devil's Back-bone to the south-west, yet it was sufficiently persistent to be considered an extension of that ridge.

Johnson, W. half of S. W. Sec. 17, T. 23, R. 24. There are several old workings in this vicinity, consisting of tunnels and shallow incline shafts which were made in 1840 to 1845; when, judging from the old dumps and the extent of the workings, quite extensive mining operations were carried on.

This Johnson property is located in the forks of the river and Sweet Water creek on the north, or rather north-west, side of the river. The outcrop of quartz, much of which prospects, is quite bold and prominent, continuing along the line of strike N. E. and S. W. with hardly a break, to the river, a distance of about a mile and a half.

The character of this quartz is sandy, sugary, very much stained with iron oxide, partially decomposed and porous.

A sample selected at haphazard, analyzed by Dr. J. H. Pratt of Birmingham, Ala., yielded $3.43 a ton in gold. In panning several samples I noticed that the results averaged very evenly, more so than almost any other quartz outcrop I have tested in this State. These were all taken at haphazard from the outcrop, and were not sampled systematically by quartering as should be done; but I lacked both time and facilities for doing such work.

As is the case on the opposite side of the river, some work was done here ten or twelve years since, and ore milled. At the present time, though the openings are in such a condition that it is impossible to estimate the character or extent of the ore body, except from the outcrop, which, while it has a general line of strike and dip, has but little regularity in structure.

The gold contained in this ore is very fine, but appears to be free-milling at and near the surface, though undoubtedly sulphurets will be present at depth. To the south-west on the

Griffin property, Sec. 19, T. 23, R. 24 E., the same lead of quartz, apparently, can be traced across that tract from which it enters the river. No work of any description had been performed here at the time of my visit, nor indeed could I learn of any other mining work, having been carried on along the line of strike of this Silver Hill belt to the north-east in this State.

My attention was attracted to the different appearance and nature of the quartz occurring in the several leads on the two sides of the river, in the Devil's Back-bone proper, as well as in the parallel ridges, a mile or more to the south-east, where most of the mining has been done. While the gold-bearing ore on the northern side of the Tallapoosa, so far as I observed (and I saw, and tested samples by panning, from all the known bodies which outcrop, or have been mined), is of a sugary,

sandy character, somewhat decomposed and porous, and plentifully stained with iron oxide; that on the southern side, especially in the southeastern-most bodies, is of a hard, glossy and flinty nature, carrying a large per centage of sulphurets, and some magnetic iron.

North-East of Eagle Creek District.

To the north-east along the line of strike of the country rock, I traced this belt across Galloway creek about 2 miles south of Daviston, where I found apparently the same ledge of slate as at the New Yorker Shoals with quartz interpolated between the strata. Thence to Hardnett's Mill creek, two and a half miles further to the north-east, where the same ledge crosses the creek a short distance north of the mill. Thence to the Mountain Spring church on the Chambers county line, Sec. 19, T. 24 N., R. 25 E.

A short distance from this church, to the north-east, in the same section, and along the crest of a high ridge, from which the church derives its name, the outcrop of quartz again assumes the bold outlines it possessed along the Devil's Backbone in the vicinity of Blue Hill, and rises several feet above the surface in immense slabs and boulders. Some of this quartz is in place, but no enclosing walls of country rock are exposed, except in such a rotten state as to render its classification quite difficult. Near by, though where less decomposition and erosion have taken place, the country rock, are the same semi-crystalline slate and hydro-mica schist, which characterize the entire belt. The dip of this quartz in places is almost vertical, and the strike conforms with the general line N. 40° E. This quartz is of the same sandy, friable character as in the outcrop along the Devil's Back-bone proper, but samples I took failed to show any colors of gold in the pan, although the presence of black sand with some sulphurets indicated that

there might be gold bearing chutes or chimneys in the body. I followed this outcrop along the ridge and towards the Tallapoosa river, which it crosses at the mouth of Laney creek, about one mile below Denny's Ferry, and five miles due east from Daviston. I could find no openings on this outcrop along the ridge, or in this semi-crystalline formation in this vicinity, to indicate that any prospecting had been done, nor could I learn of any work which resulted profitably having been performed on this Silver Hill belt north-east of the river at any point between it and the Alabama-Georgia Line.

The belt of semi-crystalline slate and hydro-mica schist maintains its continuity, with many seams of quartz interstratified, as I demonstrated by crossing the formation at various points along its line of strike. The course is north-easterly from Denny's Ferry across the north-western corner of Chambers county; thence into Randolph south-east of Louina, crossing the county, passing near Handley P. O., thence to the State line.

Near Rock Mills, Randolph County, about five miles in a direction slightly north of east from Roanoke, and in Sec. 27, T. 21, R. 13 E., it is reported that while the Indians resided in that vicinity, as well as more recently, placer gold has been found in the bed of Wehadkee creek, but no signs of any extensive work can be found.

So far as I could ascertain the occurrence of gold in this section is based entirely on legend and tradition; many stories of the Indians bringing gold dust to the traders in small quantities are related by early settlers, but no one appears to place sufficient faith in such accounts to feel warranted in expending money for prospecting during recent years.

So far as I could discover from my own tests, as well as the best information I could obtain on the subject, I feel warranted in stating that no gold in paying quant-

ities occurs in Alabama south-east of the Silver Hill belt; although the crystalline schists, hornblende and gneiss formations continue in a south-easterly direction some 40 miles, or to the latitude of Columbus, Ga.

OCCURRENCES OF MICA, CORUNDUM, SOAPSTONE AND ASBESTOS.

Immediately south-east of the Silver Hill belt, and paralleling the same, we find first strata of graphitic slate, which I noticed at one point on the Germany Ferry road between Daviston and Dadeville on the north-west side of the Tallapoosa river, to be at least 40 feet in width where the public road cross cuts the slates. Next in the series of mineral belts paralleling the Silver Hill, are veins of coarse grained granite, from which mica in crystals sufficiently large to possess a commercial value, has been mined. I found the best points to study these parallel belts was in the vicinity of Dadeville and Buttston, also near Easton P. O. about 7 miles northerly from Dadeville.

From my observations in this neighborhood, I found that the mica belt just referred to, was followed by a belt of soapstone.* Associated with which were corundum and asbestos. In its turn the soapstone was followed by another belt or series of veins of coarse grained gneiss, and mica schist which indicated the occurrence of mica of commercial value.

This last occurrence of mica together with the soapstone and other minerals are what is locally known as the mica, corundum and asbestos belts; which parallel the strata of graphitic slate, in their turn paralleling the Silver Hill gold belt on the south-east border.

I have observed in Carroll county, Ga., apparently the same series of mineral bearing formations; which cross

*The soapstone, and other minerals here mentioned, are associated with masses of basic igneous rocks (pyronene and chrysolite) and some of them—soapstone chlorite and are the products of the alteration of these by weathering. E. A. S.

that county in a north-easterly course. Although the outcrops are not continuous above the surface, yet I am of opinion from the general character of the formations that these belts are south-western extensions of those in Georgia. Especially, as I am reliably informed since the same occur in Heard county, Ga.

So far as I could ascertain the only work of any extent that had been performed in search for

Mica in this neighborhood, or indeed anywhere on this belt, was on the Holly plantation about 2 miles east of Easton P. O. Here a pit some 15 feet deep had been recently sunk and merchantable mica mined and shipped to St. Louis. But at the time of my visit (Nov., 1893,) the work was suspended, and from the manner in which it had been done, it was impossible for me to form any idea of the permanency of the deposit.

Immediately north of this belt bearing mica, extends what is locally known as the

Corundum and Soapstone belts where about 12 years since Dr. Lucas, a resident of North Carolina, who had purchased a tract of land on the Tallapoosa river, including a portion of the New Yorker shoals, with the avowed intention of utilizing the water power for manufacturing purposes, gave the industry of corundum mining quite an impetus by purchasing the product of this belt. He paid from $50.00 to $60.00 a ton, but was driven from the market by another dealer, who for a time paid a higher price, but ultimately failed. Since then the industry has been entirely abandoned in this section of the State. I visited some old openings that were made at that time on the Hanby plantation, adjoining the property, on which is located Easton P. O. on the east; also at the Bartlett plantation 2 miles north of Dudleyville, and the Holly plantation 2 miles north of Hanby's.

At the last named, soapstone only had been found, and mined to a limited extent; some of the blocks which had

been sawed out at the time active mining operations were being carried on, still remain on the ground.

Whether sufficient corundum can be found in the beds on this belt, to be of commercial importance in the future, is impossible to estimate. The old openings are partially filled up with debris, and apparently were sunk until a hard variety of soapstone was encountered and then abandoned.

I find this corundum and soapstone belt extends as far to the south-west as the vicinity of Dadeville, and to the north-east in the neighborhood of Milltown, but as to the exact extent longitudinally, I have not determined.* In width it is of inconsiderable extent so far as at present known; not exceeding 2 miles, so far as I can learn, at any point.

There apparently occur two series of beds with parallel lines of strike; both of which cross the Hanby plantation, before referred to; but I can find no trace of the occurrence of any corundum or soapstone north of the Bartlett plantation and south of the Silver Hill gold belt. This last named property is in a line north-east from the Hanby, and distant about 5 miles.

On the Germany Ferry road to Dadeville the most northern indications of corundum and soapstone occur at the crossing of Soapstone Creek 2 miles south of the ferry. At this point immense outcroppings and a ledge of chrysolite rock show in the wagon road, which apparently has close connection with the soapstone corundum beds; for the same rock is again found on the Griffin Ferry and Dadeville road near an old church, in the northern portion of T. 22, R. 24 E., as well as at other places along the line of strike.

*Another somewhat similar belt is on the N. W. side of the Devil's Backbone ridge, showing near Foshee's Mill (Fosheeton) and far to the southwestward at Robert Goodman's, south of Alexander City. At Goodman's a considerable quantity of corundum has been observed. E. A. S.

I also found some samples of

Asbestos closely associated with the corundum and soapstone, at the Bartlett plantation, but of a very poor quality; as good, however, as that found in Carroll county, Ga., which at a depth of 12 feet was not of sufficiently good grade to command any commercial value.

Whether the grade will improve as depth is attained in the workings I am unable to state; but so far as I could learn from personal observation or information, no work has been done on the Alabama side to determine this.

One and a half miles north of the Bartlett plantation the Tallapoosa River flows, and between these points some mica has been found, along that northerly belt I have referred to already, as paralleling the graphitic slate, but of inconsiderable quantity, so far as at present developed.

The country rock associated with the corundum and asbestos is a talcoid-schist; with boulders of soapstone, and a green colored rock probably chrysolite, there are also specimens of actinolite and tourmaline plentifully found with the float and surface rocks. A ledge of dark green hornblendic rock is also a noticeable feature in the geological formation, which I have failed to find elsewhere in this crystalline region, except along the line of strike of these particular belts. The largest outcrop of this is near Dudleyville, where the wagon road cross cuts it angling. * This is on the road between Dudleyville and Buttston.

The mica-schist and gneiss formations are continuous paralleling the Silver Hill belt on the S. E. to the Alabama-Georgia boundary line, crossing Randolph county through Roanoke, thence by Rock Mills to the line, into Heard County, Ga.

* See foot note to page 18. E. A. S.

GOLDVILLE AND HOG MOUNTAIN BELT.

In my report I have retained the same name for the upper portion of this belt, which occurs to the north-west of and paralleling the Silver Hill, as that used by Dr. Phillips in his report on the Lower Gold Belt. My examination of this began in Clay county; because in the report of Dr. Phillips above mentioned, the south-western portion of this belt has been fully, and very ably described.

TOPOGRAPHICAL AND GEOLOGICAL FEATURES.

Before taking up the description of the gold leads on this belt, I will occupy a little space in briefly describing the geological formation of the fully crystalline region which intervenes between the Silver Hill belt of semi-crystalline slate and hydro-mica schist, and this Goldville belt, which is formed by the Talladega and other semi-crystalline slates; with boundaries of gniess and flat rocks, usually called granite, both along the south-east and north-west borders.

The average distance intervening between these belts is about 6 miles, which can be definitely traced on the map, by drawing a line with a N. E. S. W course intersecting Daviston on the north-western boundary of the Silver Hill belt and New Site on the south-eastern boundary of the Goldville belt. In Randolph county the semi-crystalline slates are greater in width than in Clay or Tallapoosa counties, and have intruded on the fully crystalline, or vice-versa; for it is not yet decided which formation is the older. This intrusion* is

*See Part II of this Report, where reasons are given for thinking that the structure of these crystalline rocks is not *stratification*, but a secondary character (*schistosity*) produced by dynamic metamorphism of originally massive igneous rocks. E, A. S.

really interstratification; because the series of the formation follow each other conformably. But alteration appears to have taken place along the line of the strike; so that in traveling across the formation from Louina to Almond P. O. a series of strata of semi-crystalline slate occur, which are not seen south of the Clay county line. While in traveling from Roanoke to Wedowee these fully crystalline schists and gneiss appear to be narrowing down, and about 1 mile east of Wedowee disappear entirely, with the exception of about 100 acres of gneiss and flat rock occurring about 2 miles north.east of Wedowee, portions of Sec. 23 and 24, T. 19, R. 11 E. Immediately paralleling the Silver Hill belt on the northwest in the vicinity of the Eagle Creek Mining District I found massive boulders and beds of gneiss, which maintain their continuity longitudinally to the Alabama-Georgia State line. On the line of strike towards the north-east this bedded gneiss assumes the structure of

Flat Rocks in many places on both borders, and is usually designated as granite, and often as dikes. But although these flat rocks in some places cover several acres, as at Almond P. O., (at that place the flat rocks cover nearly or quite 200 acres, being 2 miles in length N. E. and S. W. and ¾ mile wide,) I find the lines of stratigraphy* quite well defined, showing conformity in the bedding with the semi-crystalline slates on both S. E. and N. W. The same state of facts I find on close observation prevails wherever these flat rocks occur, consequently instead of treating them, and writing of them as granites, I shall refer to them always as gneiss. As these occurrences are possessed of a commercial value, I have taken pains to locate the most prominent in this portion of the State as follows:

Almond, S. E. of Sec. 29, S. W. Sec. 28, T. 21, R. 10 E.

*See preceding foot-note. E. A. S.

Almond, Sec. 5, T. 22 S, R. 10 E.
Motley Mill, Sec. 4, T. 24 N. R. 24 E.
Handley, Sec. 22, T. 20 S., R. 12 E.
Forester's Chapel, Sec. 29, T. 21, R. 11 E.
Portions of Secs. 28 and 27, T. 21, R. 10 E.
Rock Mills, Sec. 27, T. 21, R. 13 E.

The foregoing all occur on the north-western border of the Silver Hill belt, except the exposures at Rock Mills, which is in the crystalline region south-east of this belt.

The exposures along the line of strike of the gneiss forming the north-western boundary of the Goldville belt, are as follows:

Knight's Mill, Sec. 35, T. 20, R. 9 E.
Carwile, S. E ¼. Sec. 34, T. 20, R. 9 E.
Wm. Orr, N. W ¼. Sec. 35, T. 20, R. 9 E.
Dawkins, Sec. 8, T. 21, R. 9 E.
Grizzle, N. W ¼. Sec. 24, T. 20, R. 9 E.
Blake, N ½ S. E ¼. Sec. 18, T. 20, R. 10 E.
Blake, S½, N. E ¼. Sec. 18, T. 20, R. 10 E.
Devon, S. W ½. Sec. 18, T. 20, R. 10 E.
Moore and Duke, portions of Sec. 23 and 24, T. 19, R. 11.

The only place where any quarrying is at present being carried on is on the last named exposure, which is two and three-fourths miles north of Wedowee. Here a firm of bridge builders, the Alabama Bridge Company, are quarrying the rock for piers and abutments for a new bridge across the Little Tallapoosa river on the wagon road to Heflin. About 500 tons will be quarried for this purpose, and the rock is pronounced as of a very superior quality. An ample supply, I was informed by the contractors, will be obtained without the necessity of quarrying to any considerable depth; in fact, at present, only the rocks which have become split by weathering have been used.

I can not learn of this rock having been quarried and used for building purposes within the boundaries of the Upper Gold Belt, but such has been done at Rockford and Goodwater in Coosa county with very satisfactory results. The rock from that vicinity has the same characteristics as that found in Randolph county, where such rock has hitherto only been utilized for gravestones, mill stones and chimneys.

These belts of gneiss are followed on the south-eastern border of the Goldville belt by the semi-crystalline Talladega slate. The general dip of this entire Upper Gold belt section of the crystalline region inclines towards the east and south-east. The structure is, I notice, generally conformable at the lines of demarcation between the gneiss, and either the slates or schists; and I failed to observe at any point any special change in the dip, or any appearance of greater deformation than is usually seen in this section of the Appalachian system. The dip generally throughout the Goldville belt is more nearly vertical than in some other sections, but the changes in the dip at these lines of demarcation I have referred to, do not appear extraordinary, as would be the case if the gneiss strata were granite dikes, though such conditions even might be produced by shearing, which from Dr. Becker's report published recently is that authority's opinion. A study of the formations bordering this Goldville belt in the south-western direction demonstrates that these gneiss belts are continuous, and persistently maintain their places in the series in the Lower Gold belt. So that by actually following along the line of strike on either border of this gold belt I am of opinion that the gneiss will maintain its continuity longitudinally equally as persistently as do the mica schists, hornblendes or slates.

DETAILS OF GOLD OCCURRENCES.

I really took up my work of examination of the Upper

Gold belt near Almond P. O., in the south-western corner of Randolph county, where I made every effort in my power to connect, or discover a north-eastern extension, of the gold bearing lead, which is described by Dr. Phillips as maintaining its line of strike so persistently from Hillabee creek to the northern line of Tallapoosa county. But I could find no occurrence of gold-bearing ore, so far as at present known, on this belt, south-east of Malone's ferry, Sec. 11, T. 21, R. 10 E. On the

Browning property, Sec. 8, T. 21, R. 10 E., about two miles north-west of the ferry, I found the first occurence that had been prospected. This is the southernmost ore body in this formation on which any prospecting had been done on the Upper Gold belt. The shallow prospect pits exposed a low grade of gold-bearing ore, but the work, at present, is insufficient to determine the value of the occurrence, or any facts relative to permanency, or extent of the ore body.

From this point I proceeded to the old Bradford settlement, now known as the

Goldberg Mining District,

on Crooked creek, on the west side of the Tallapoosa river. This has heretofore generally been considered to be a north-eastern extension of the gold-bearing lead from Hilabee creek to Goldville in the Lower Gold belt. In being located in the same strip of semi-crystalline Talladega slate, it may be considered so still. But while lying in the same country rock, I found that the Goldville * lead proper occupies a position on the south-eastern edge of the gold-bearing formation, while the Goldberg lead occupies a position near the north-western edge of the same formation. If there should ever be established any connection along the line of strike of the ore bodies in this belt, I am of opinion that the Goldberg will be found to be continuous with Hog Mountain lead, which

* In designating these series of occurances of gold bearing ore as leads, I do not use the term with exactly the same meaning as is given to such generally in the western mining districts, but rather with the meaning as defined by Webster "a guide."—W. M. B.

also occupies the same relative geographical position in the belt. But from examination I doubt if any of these leads of gold-bearing ore continue unbroken along the line of strike for any great distance.

I should, from the indications, think that the Browning prospect might be considered an extension of the Goldville proper. To substantiate my conclusions in this respect I find that about 4 miles north of Flat Rock (Almond P. O.) several strong seams of quartz have been cut in working the wagon road known as the Wesobulga and Flat Rock road, but such are barren at this point. These veins or seams apparently persist through a prominent ridge, which is situated geographically to the north-east of the Birdsong pits near Goldville P. O., and in the same semi-crystalline slate formation, having the line of strike corresponding with that of the strata in the Lower Gold belt. The discoveries in the Goldberg district are four miles north of the general line of strike of the Goldville lead proper.

The point where the south-westernmost discovery of gold-bearing ore, on this belt in the Upper Gold region, was made is on the

Dawkin's property, S. E. ¼ Sec. 2, T. 21, R. 9 E. The work comprises some openings made prior to 1860, from which I obtained some ore; a slightly decomposed quartz. By panning I failed to get colors; although the showing of sulphurets was good, and there was some indication that a fire assay would probably show a satisfactory yield in gold.

Within the recollection of some of the oldest settlers a "pounding mill," as it was designated, was operated near the location of these old openings; and the ore mined from them, was there treated by amalgamation.

My attention was next directed to some recently dug openings or shallow prospect holes, on the crest of a ridge, on this same property. The surface of this ridge

is plentifully covered with quartz float, and ledges of quartz outcroppings, several in number, with their lines of strike parallel, and having a trend nearly north. These holes I found to be too shallow to enable me to determine the structure of the occurrences; whether they should be classed as bedded veins or as belonging to a stratified deposit.

The ore when panned yielded fair prospects in free gold. It is so far as exposed, of the character and appearance of a feldspathic quartzite, somewhat decomposed, and stained with oxide of iron. The feldspar was decomposed, and kaolin appeared as the secondary product.

The outcrops of some of these strata can be traced to, or rather appear again above the surface on the crest of another ridge, about 400 feet distant in a southerly direction. Judging from the strike these may prove to be extensions of those exposed in the old openings on this property. But such can not be determined because no work has been done to establish or demonstrate such continuity to be a fact, and the outcrops can not be traced above the surface except on the crests of the hills. The location of this plantation is near the forks, and comprises the land enclosed by White Oak and Wesobulga creeks, near, and for some half a mile above, their confluence in Clay county.

Knight's Mill, S. ½ S. E. ¼ Sec. 35, T. 20, R. 9 E.—At this point is a clearly defined line of demarcation in the formation, between the Talladega slate and bed of gneiss, having somewhat of a porphyritic character. This gneiss extends to the southward half a mile or so, but its structure conforms, both on the north-western and south-eastern edges, with that of the semi-crystalline slate country rock.

Narrow quartz veins are found imbedded in the gneiss, some of which prospect colors by panning. But such

are too thin, to ever offer any inducement for prospecting, being only from a half inch to four inches thick at the outcrop.

W. D. Mitchell's property, S. 1, T. 21, R. 9 E.—Following White Oak creek down to its confluence with Wesobulga creek on to this property, I found an occurrence of gold-bearing ore a short distance below the junction of the two creeks; in a field adjoining the Heflin and Louina dirt road on the south. Shallow prospect holes had been sunk on a ridge where a vein or seam of hard quartz, stained with iron oxides, had been exposed bedded between the strata of slate. The strike of this was slightly east of north, with its dip towards the S. E. at an angle of 35 deg. The ore panned satisfactory results in free gold; but pan tests on all the ore sin this belt, I found, after testing, to fail to give as good results as could be obtained by roasting and pan amalgamation.

I am unable to give the exact yield of any of the ores, except of a few samples assayed by Dr. J. H. Pratt for the survey; because in the field I lacked facilities for assaying the same. In making tests I am under obligations to Mr. George Camp, a veteran prospector from the West, for valuable assistance, while in this district. By the aid of a blacksmith forge, a frying pan, mercury and porcelain bowl we amalgamated samples with an exactness hardly fo be expected with such crude appliances. As we had no balances we could not determine the values of the ores except approximately, and as such estimates are liable to prove faulty, I have refrained from quoting figures. However in cases when I state that a test proved satisfactory, I am satisfied that $5.00 a ton is a conservative estimate.

It was on this same property, and in close proximity to the last occurrence mentioned, that I saw work done on another quartz seam. This exposed such a rich kidney or

pocket, as is rarely encountered. The seam of quartz outcropped on the same ridge, as the first I have mentioned, on this Mitchell property, but distant about 100 yards in a south-easterly direction. The dirt road before mentioned cross cut the quartz seam, and on the northern side of the road the cut was about 8 feet deep.

I had previously been told of a very rich pocket of ore having been discovered on this same body several years before. The discovery though had not been followed by any systematic work; and the hole that was sunk at that time it was claimed had been filled in by the road workers.

The story appeared to me to possess many of the earmarks of an Arabian Nights romance; but Bob Bradford a local prospector insisted that he believed he could, by following the dip of the vein, which is about 35 degrees towards the south-east, discover another pocket. My curiosity prompted me to witness his work.

After sinking about 4 feet below the surface of the wagon road, he was as good as his word, and took from a pocket or kidney in the quartz vein about 75 pounds of ore. This had all the characteristics of arseno-pyrite or mispickel, and when roasted showed that such was the nature of it. During the roast the arsenic and sulphur were sufficiently eliminated to set free the gold, when by stiff pan amalgamation 1¼ pounds of the ore yielded a button of gold of the value of 17 cents, or nearly $300 a ton. Future work at the same place failed to show any more such pockets, but such work only attained an increased depth of about 6 feet. The thickness of the quartz vein at the depth attained was 12 inches. It is apparently interleaved between the slates. The float as well as some outcroppings would indicate that it may persist along the strike of the formation parallel with the seam of quartz I first examined on this same property, and have already referred to. The dip of both

these quartz seams is in the direction of the gneiss rock I found interstratified with the slates, and which shows in a mass above the surface, 30 feet to the south-east of the prospect hole in which the pocket was discovered.

On the north-eastern extension of this ridge and about 200 feet from the road another prospect hole had been sunk which exposed still another vein of gold-bearing quartz, with its strike parallel to the two first mentioned, and dipping conformably with the formation, and also with the dips of the other quartz bodies. The structure of these ore bodies as well as their permanency and extent, can only be determined after more work has been done.

My own opinion is that they will continue down conformably with the stratigraphy or cleavage of the country rock, and be subject to the same folding and faulting as that has sustained.

The gravel in Wesobulga creek prospects well in placer gold, at the crossing of the Heflin and Louina dirt road.

Farrar property N. W. ¼ of S. W. ¼ Sec. 36, T. 20, R. 9 E. On this property my attention was directed to some old workings, consisting of a tunnel 50 feet long, and a deep shaft; where mining operations had been carried on before the war of '61 to '65. In the tunnel, which I explored, I found some gold-bearing quartz which prospected by panning. But I was unable to determine the extent or character of the ore body in place, because of the dangerous condition of the opening.

This was really a cross cut, having been run at right angles to the strike of the formations; from the size and appearance of the dumps, as well as condition and extent of the openings, these workings must have been quite extensive for their date. However, I could find no outcrop exposing rock in place in the vicinity of any of these old workings, although pieces of quartz float of a sugary character, stained with iron oxide, and consid-

erably decomposed were very plentiful on the surface; covering several acres.

The only recent work performed on this property which exposed the occurrence of gold-bearing quartz, was the sinking of a well in which a ledge of quartz 15 inches thick was cut near the surface. The strike of this is slightly north of east and south of west, with its dip towards the south at an angle of 25 degrees.

The slate country rock underlying this seam of quartz was mineralised, and prospected by panning as also did the quartz from the vein.

One of the legends of the neighborhood is to the effect, that in the ante-bellum days, old Mrs. Farrar used to pan in the branches which flow through this property. From the gold she obtained, the story goes, she was able to furnish herself with all the pocket money she needed, besides supplying the table with coffee, sugar and other luxuries.

W. D. Mitchell S. W. ¼ of N. W. ¼ Sec. 36, T. 20, R. 9 E. This property adjoins the Farrar tract on the north. Gold-bearing ore, very highly sulphuretted, and having the characteristics of arseno-pyrite, occurs, and a shallow prospect hole had been sunk, but the work was insufficient to enable one to determine any facts as to extent, permanency, or value of the prospect. The ore yielded satisfactory results when roasted and treated by pan amalgamation.

No outcrop was exposed on the surface, so that no idea could be formed of the occurrence, beyond the showing in the shallow pit. This class of ore I usually found nearer to water level, but in this instance it occurred on the crest of a high ridge, and close to the surface.

Dr. Manning's Property, Portions of Secs. 25 and 36, T. 20, R. 9 E.—A portion of this property forms one of the old land marks, with regard to placer diggings. These must have been worked not less than 60 years ago, for

the tailing dumps are buried under two feet of soil today, and trees 10 to 12 inches through have grown thereon. From all appearances placer mining must have been carried on quite extensively here in days gone by. But the deposits were not entirely worked out, because at the present time good prospects are obtained in coarse gold, from nearly any of the gravel bars in the creek beds. However these bars are not extensive, and would hardly pay to work. Most of these old diggings were on branches which empty into Crooked Creek on this property, and the section adjoining it on the south.

Gold-bearing ore bodies also occur in the quartz. From the appearance of these ore bodies at several openings on the crest and near the base of a steep ridge, I am inclined to class such as stratified deposits rather than veins, because the strata of gold-bearing rock, and decomposed mineralised slate lie conformably with the general formation, are in fact a portion of that formation, having no well defined walls.

The general line of strike is about N. 40 deg. E. but at some of the openings the folding has been so violent and extreme, that the formation has no general lines of strike and dip; but both are abnormally twisted and contorted, and point in nearly every direction. This state of facts though is only local. At one opening in particular the crest of an anticlinal curve is clearly defined. Several thin veins of quartz, very much stained with iron, but quite hard, cut the formation at right angles. These pan very richly, but are so thin, no work has been done with a view of developing them.

The richest pan tests so far obtained in this district in free gold, I got from average samples on this property. Assays made by Dr. Pratt yielded from samples taken on Sec. 36, $23.03 a ton and $10.42 a ton. These were selected at haphazard, and not from systematic sampling.

The ore in the stratified deposits from the lower strata has arseno-pyrite characteristics, carrying on excess of sulphur and arsenic; but near the surface it has become oxidised, and is of a free milling nature.

Cockrell, N. E.¼ of S. E.¼ Sec. 25, T. 20, R. 9 E.—This property joins the Manning on three sides, the north, west and south; and the waters of Crooked Creek flow through the north-east corner. Here the creek has been dammed, the water-power being utilized to run a grist mill and gin.

A short distance to the north-west of the mill, occurs the outcrop of a gold-bearing quartz seam, between slate walls, with its dip south-east on an angle of 25 deg. The hanging wall (where exposed in a shallow pit) is more vertical than the foot wall, and if such a conditition is continuous for any considerable distance in depth, the permanency of the ore body is certainly endangered. The openings were all quite shallow, indeed so much so, that nothing beyond the occurrence of the ore between the slates could be determined. The character of the ore is the same as I have before referred to as a feldspathic quartzite. Usually on this belt where ore of this character occurs near the surface, it is replaced as depth is attained by a more or less decomposed quartz and sulphuretted ore, from which in some cases rich results are obtained, This feldspathic quartzite, which appears closely allied to mica-less *granite*, in general appearance, rarely gives more than colors, and often only sulphurets. From this last described property I crossed Crooked Creek, which here forms the boundary line between Clay and Randolph counties; leaving the first named and entering the precincts of the last.

Goldberg Mining Company, S. W.¼, Sec. 30, T. 20 R. 10 E.—From the Manning property in Sec. 36 I had followed by observation the lead of gold-bearing ore, and discovered that in a north-easterly direction, as you ascended the slope

of a ridge the float and outcrop denoted another body or an extension of the first. This ridge is continuous, except where the waters of Crooked Creek have cut a channel through it, for some considerable distance, and is locally known as the "Bradford Ridge." On this, and another parallel ridge, the company from which this district derived its name, performed prospect work in 1893.

The work done was of a more extensive nature, and more systematic than on most of the properties I had examined on this Upper Gold belt to the south-west. From it I was enabled to form a more comprehensive idea of the structure, extent, and nature of the ore body. At one point an open cut showed a thickness of pay ore 16 feet. At another a shaft sunk on an incline conformably to the dip of the formation, and with the dip at an angle of about 20 deg. towards the south-east, was in ore for a distance of 50 feet from the mouth. This showed a thickness of 6 feet of ore at the face, with ore still below the floor.

These openings were made on the Bradford ridge, a short distance north-east of Crooked Creek.

The first of these (the open cut) showed all the characteristics of a stratified deposit, composed of quartzite, slate and clay interleaved, and capped by a hard quartz. No walls enclosing this ore body could be discovered; the entire thickness prospected, and some of the strata yielded quite rich results. The dip of this deposit conformed with that of the formation in the shaft. But at the heading in this shaft the dip increased to an angle of about 45 deg.; there water interfered with further progress. The ore body at this point was more solid, and the distinction between pay ore, and country rock better defined.

From the increased angle of the dip together with this change in the ore body, I was led to believe that as

depth was attained the structure might change and assume the characteristics of a segregated or bedded vein.

This theory I found sustained by the conditions at the Franklin mine in Cherokee county, Ga., which I visited in 1893; the country rock was a mica-schist though, instead of slate. The solid formation at that mine was encountered at a depth of 115 feet. Sinking was continued on an incline shaft until it reached a depth of 425 feet, on an incline of 45 degs. From the point where the solid formation displaced the decomposed material, well defined slate walls enclosed an ore body of about 16 feet in thickness, bedded in conformity with the dip of the slate, and apparently continuing down, an undetermined depth.

Above this solid formation, I was reliably informed that the body was composed of such strata of quartzite and mineralized schist with clay as occurs on the Goldberg property, the only difference being the nature of the country rock and the angle of the dip. Besides the two openings I havementioned on the Goldberg property on the Bradford ridge, I found several others of greater or less extent, along the line of strike of the ore body. In all of these the same character of ore had been exposed, which tended to show that the body was continuous along the strike, a considerable distance. The ore, as depth was attained in the incline shaft, carried a greater percentage of sulphurets, and after roasting, prospected much richer than at the surface. While the average yield will not exceed $5.00 per ton, yet some picked samples have assayed as high as $100.00.

The following assays from this property were made for the survey by Dr. Pratt, of Birmingham, Ala., from samples taken at haphazard: $5.15, $3.14, $2.56 a ton respectively.

On a ridge parallel to and a short distance to the northwest of the Bradford ridge, and within the boundaries

of this same property, several shallow openings had been made exposing gold-bearing ore. But the work was not sufficiently extensive to enable me to determine any facts, except that from the dip of the strata of these ore bodies, if the continuity is maintained across the trough dividing the two ridges; these last mentioned strata would underlie the ore body already exposed on the Bradford ridge.

My attention was also directed to some thin true veins cross-cutting the formation, on this northerly ridge. These vary in thickness from 6 inches to 15 inches, and pan much richer than the stratified deposits. No work has been done on any of them to show what results would follow from development. The ore is a very hard quartzite, very much stained with iron oxide, and at the surface free from sulphurets.

On the north side of Crooked Creek, the gold-bearing belt appears to widen out as you follow it towards the north-east.

The Goldberg Company having determined to their satisfaction the character, and partially the extent of the ore body, talked of making preparations to perform permanent development work, and erect a plant for treating the ore. At the present time though all work by this company has been suspended.

The ore is of a refractory nature and will not yield to treatment by ordinary amalgamation. Because while the percentage of free gold is large; yet the presence of arsenic, sulphur, with sometimes traces of antimony and copper certainly place it in the refractory or rebellious list.

Bradford Fraction, Sec. 30, T. 20, R. 10 E.—This property consists of 30 acres in the extreme S. W. corner of the section, and comprises a high ridge which extends to the north-east from Crooked Creek parallel with the Bradford ridge, I have before mentioned, and distant

about half a mile to the north-west. Here I found an opening on an ore body with its line of strike nearly north-east and south-west, and dipping almost flat towards the south-east. The ore has the same appearance as the feldspathic quartzite referred to as occurring in other locations in this district. At another location on lower ground, the ore is an arseno-pyrite, somewhat resembling gray copper, but sometimes showing free gold visible to the naked eye.

These openings were not of sufficient extent at the time of my visit to enable me to form any opinion as to value, or extent.

Assays by Dr. Pratt of two samples from this property yielded $5.15 and $3.95 a ton in gold.

Bradford Ridge, N. W. ¼ of S. E. ¼ Sec. 30, T. 20, R. 10 E.—On the Bradford Ridge proper, of which the Goldberg ore body is in the south-western extension, I find more extensive prospecting work has been performed than elsewhere in the district. Several openings have been made about a quarter of a mile north-east of the Goldberg property.

The first I visited is an open cut, run into the hillside until a breast 20 feet in thickness was attained. This is composed of strata of quartzite, decomposed slate and clay; the whole mass apparently being gold-bearing, and forming a stratified ore deposit. Prof. Aughey informed me that from three picked samples representing this entire thickness, assays showed $17.75, $18.00 and $16.50 a ton in gold respectively.

From this heading I took several samples at haphazard, some of which assayed by Dr. Pratt, of Birmingham, only yielded $7.23, $7.75, and $5.15 in gold a ton respectively.

Beyond the heading of the open cut it was found advisable to tunnel, and as the work progressed the ore became harder and the body more concentrated. At one

point the strata of decomposed slate and clay disappeared, leaving a solid ore body eight feet thick. At a distance of about 50 feet from the face of the cut, the dip of the ore body becomes more inclined towards vertical; and at the heading of tunnel, 50 feet farther, it assumed an arc like shape; the ore body apparently continuing down with an almost vertical dip.

Here sinking was commenced, and had progressed to a depth of about five feet when I last saw it. The winze was in ore, but water was rising and threatened to interfere with the work unless pumping was resorted to; for which no provision had been made. The ore from this winze is highly sulphuretted and of the arseno-pyrite variety, carrying both arsenic and sulphur in combination with the gold. (The richest ore found on this ridge, so far as concerns *free gold*, is a quartzite of reddish color, very much decomposed and porous.)

The open cut and tunnel do not drift on the ore body along the line of strike, nor exactly cross cut it; but the opening has been run on an angle between the strike and dip, consequently it does not expose the true thickness of the body, and is no guide by which to estimate extent.

Other openings to the south-east of this open cut and tunnel show bodies of ore overlying or overlapping the one exposed in that opening, at irregular intervals. These are all shallow, and afford little data to base estimates on. There is one shaft which has been sunk some 50 feet. In this, one stratum of ore occurs near the bottom, and work was suspended before the entire thickness was cross cut. The shaft has not been sunk deep enough to cross cut the downward extension of the ore body exposed in the main tunnel.

The ore in all these openings bears the same general characteristics, becoming more sulphuretted towards water level. Assays yielded $5.70, $5.44, $3.99, $3.95 a ton in gold. A ten-stamp mill, fitted with stamps weigh-

ing 100 pounds each, has been run on this ore for some time by inexperienced operators. With what degree of success as to saving the gold, I could not ascertain; but from the fact that all operations have been abandoned since my examination, I am of opinion that failure resulted, as I anticipated would be the case.

A branch which flows at the south-east base of the ridge on this property has been the scene of some placer mining operations, and the gravel in its bed at places still prospects.

John Turner's Property E. ½ of S. E. ¼ of Sec. 30, T. 20, R. 10 E., N. E. ¼ of N. E. ¼ Sec. 31, T. 20, R. 10 E., also a fraction of S. E. ¼ of N. E. ¼ of Sec. 31, T. 20, R. 10 E.—I have described this property thus minutely because someoccurrences of gold bearing ore are found on each tract. The property consists chiefly of three ridges with Crooked Creek flowing between two of them; and the branch I have already referred to as on the Bradford property, forming the dividing line between the Goldberg and Turner properties, as it flows towards its confluence with Crooked Creek.

The bottoms on each side of this branch are wider between the Goldberg and Turner properties than on the Bradford. Pay gravel beds extend some little distance on both sides of this branch; but not sufficiently rich to pay for sluicing, though panning shows prospects. Crooked Creek is a bold stream with considerable fall to supply power for machinery, as it winds between the ridges, and would afford ample water for hydraulic mining besides, should investigation demonstrate the gravel bars to be of sufficient extent and value for such operations.

The ridge in Sec. 31 presents many features of interest. Although the summit is now about 100 feet above the level of the creek, yet in the far distant past, this

was evidently occupied by the stream when it flowed at a higher level, before it had cut its present channel. To-day the lines formed by the receding waters are apparent, and on the highest point *iron garnets*, or limonite pseudomorphs resulting from the decomposition of pyrite, with the edges worn entirely round, as large as 45 calibre bullets can be picked up on the surface by the handful, as well as pebbles, and gravel also water-worn into rounded shape.

The surface of this ridge prospects in places, especially in the gullies on the sides; and I am informed that some fairly large nuggets have been found in Crooked Creek, near the base of this ridge.

Some shallow prospect holes expose the occurrence of an ore body of gold bearing quartz; samples from which showed colors in the pan. But the work has not been sufficient to enable me to determine the extent or structure.

Crossing the creek, I found some prospecting had been done at the south-east side and at the base of another ridge; this is the ore I have referred to as being separated from the Goldberg property by the branch which empties into Crooked Creek, and forms the dividing line. It is located in Sec. 30, and has its trend parallel to the Bradford ridge.

The work at the base resulted in exposing some ore, carrying an excess of arsenical pyrite, which assays showed was of too low grade for profitable mining. But on the crest of this ridge several shallow openings exposed a body of gold-bearing quartz of a free milling variety, which bore many of the characteristics of the quartz found in the thin veins on the Bradford fraction. By panning I obtained good results from nearly every sample I had selected at haphazard. However, the pits were all too shallow to show more than the occurrence of the ore; except but being sunk along the line of

strike at frequent intervals, proved that ore-body was apparently continuous in that direction.

W. D. Mitchell's property, W. ½ N. E. ¼ and S. E. ¼ N. E. ¼ Sec. 30; also N. E. ¼ S. W. ¼ Sec. 19, T. 20, R. 10 E.—This has been prospected in several openings, and three distinct ore bodies exposed. One known as the *Pine Hill Mine* is located on the S. E. ¼ N. E. ¼ Sec. 30. This is apparently an extension of the ore body on the Bradford ridge, as it possesses all or nearly all the characteristics of that occurrence, with the same trend and dip; as well as structure of the ore body, and nature of the ore.

The work done in prospecting in the early spring of 1896 consists of one incline shaft about 80 feet deep, and some other pits of less depth along the line of strike; as well as a drift run at right angles to the shaft 40 feet below the surface. Some samples from this prospect quite richly; but a fair average showed it to be not over $5.00 ore. The drift has been run 100 feet and shows that the ore body is continuous. Cross cuts show its extreme thickness to be 14 feet, and its average not less than 6 feet, so far as exposed in the workings.

On the tract in Sec. 19 a vein, with its strike almost due east and west, and dip vertical, occurs. This possesses many of the characteristics of a true vein, but is only about six inches thick at the outcrop, widening though to twelve, within ten feet depth, and twenty-four at eighteen feet depth. This is as deep as it has been sunk on, which is hardly sufficient to determine what results further development will show. But sufficient to warrant its being classed as a good prospect; especially as the ore is free milling, and richer in the average yield than any in the district. Fifty feet to the north of this occurs another vein possessing the same characteristics as the first, and eighteen inches thick where exposed.

Adjoining this property on the north and north-west,

we find the extensive beds of gneiss, in which are the flat rocks (granite), known as the Blake's Ferry flat rocks, and in which no occurrences of gold-bearing ore have been discovered.

Teakle property, W. ½ N. W. ¼; N. W. ¼ S. W. ¼; S. E. ¼ N. W. ¼; Sec. 29, T. 20, R. 10 E.—This property, together with some adjoining tracts located at the confluence of Crooked Creek and the Tallapoosa River, is locally known as "Hunt's Quarters,"—deriving its name from the fact, that during the war a man named Hunt bought a number of negroes from the State of Mississippi and kept them here. A series of ridges extend across this property with their lines of strike N. E. except at a few places where folding by lateral pressure has bent the semi-crystalline slate formation from the normal line. These cases are only local, and the general trend in such instances has been resumed, a short distance, from the points where deviations occur. Several prospect holes have been sunk on two of the ridges, exposing bodies of sulphuretted ore. But such are not deep enough to furnish any data; in fact, in only one or two has rock in place been reached. Consequently these bodies present the appearance of irregularly formed pockets, or masses of arsenical-pyrite and quartz without stratification.

It is claimed that at one opening, a deep shaft, known as the "Orum Pit," which was sunk several years ago, a vein of quartz bedded in the slate was discovered. This, I was informed, was enclosed between well defined slate walls; but the condition of the shaft was such, at the timeof my first examination, that I was unable to explore it. Since then, in September, 1894, I have made a second examination because of learning that such a vein had been discovered, and opened on, to the south-west of the "Orum pit" about 600 feet; which was apparently an extension of the ore body mined in that pit. I found

good reasons for this theory, in the facts, that the last discovery is directly on the line of strike of the formation; the quartz carrying gold has the same general characteristics as that found on the dump at the mouth of the shaft; and the strata of country rock outcrop along the line of strike so that the continuity can be easily discerned.

At the present time—September 1894—an *arastra* is being run on this ore, a portion of which prospects richly enough to render this slow method of treatment profitable. But great care will have to be exercised in selecting the ore, which should be thoroughly roasted, before treatment, in order to obtain the full values. This arastra was shut down later during the same year because the drag rocks were not heavy enough to pulverize the ore properly and work has not been resumed.

The ore is a hard, but not a flinty, quartzite, although the grain is fine. At the surface it pans richly in free gold, but a foot or two below is heavily sulphuretted. These sulphurets yield very readily to fire, and the sulphur is eliminated with less intense heat than is usually the case.

The openings are only shallow pits, and the ore body shows a thickness of about two feet at a depth of some eight or ten feet, with the incline of the dip. This is at an angle of about 20 degrees towards the south-east.

In what is known as

Wild Cat Hollow, Sec. 29, T. 20, R. 10 E., adjoining the Teakle property on the north-east, I found some prospecting work being carried on in 1893. This is a quarter of a mile west from the mouth of Crooked Creek. A body of ore resembling arseno-pyrite in appearance had been exposed at the base of a high bluff. This will only yield any value after a thorough roast, when the gold can be separated by stiff pan amalgamation. It apparently carries no free gold, and is more refractory than any other in the district. Such may be accounted for from the fact that the ore is really from a lower level than any from other prospects.

The formation here has been subjected to such extreme folding that the line of strike is locally nearly north and south, and dip to the east almost flat.

The face of this bluff is formed by strata of Talladega slate with barren quartz intercalated; and at the point where work was in progress these barren quartz seams have, subsequent to their deposition, became auriferous. So little work had been done, though, that no idea could be formed as to what conditions would be exposed by future work.

Morris property, Sec. 21, T. 20, R. 10 E.—This is located to the north-east of the Teakle property. It consists of several ridges of semi-crystalline slate formation, peculiar to the gold districts, forming a bend of the Tallapoosa River, and on the west side. The river itself crosses the north-east quarter of this section, having a north-west and south-east course.

Some shallow prospecting work has been done exposing the occurrence of gold-bearing ore. At one point a prospect shaft 18 feet deep, exposes a body of ore 14 feet in thickness, and the bottom of the shaft is still in ore. This however, has the same irregular structure, I have remarked on as occurring at other locations in this district. The outcrop of this formation can be traced to the river, about a quarter of a mile to the north-east, at which point are shoals formed by bold and prominent ledges of slate, with quartz interlaved between the strata, but no prospecting had been done to determine whether or not it was gold-bearing. These ledges of slate ean be followed for considerable distance on the east side.—In fact the formation extends to the *Alabama-Georgia boundary line*, and beyond to an undetermined distance.

The trend of this semi-crystalline slate formation here is the same as the course of the Little Tallapoosa River, N. E. and S. W., and it continues up that river to its

source in Carroll county, Ga., south-east from the Villa Rica mines.

Although in years gone by prospecting for gold has been done on this belt around Wedowee, the county seat of Randolph county, and at other localities; yet I could obtain no reliable information of the discovery of any-body of gold-bearing ore.

Most of the prospecting has been done along the N. W. edge of the belt in the vicinity of the Little Tallapoosa River. But I could learn of no location where the work had been of recent date, or of even on such a scale as in the Goldberg District. To the north of Omaha P. O. about one and a half miles, in Sec. 32, T. 19, R. 13. Mr. Joshua Ballard has prospected on a small scale, but without very encouraging results. This is on the south-east edge of the belt. The surface is plentifully covered, through that neighborhood, with limonite pseudomorphs. Some of these are quite large, and one specimen, weighing about ten pounds, when broken open was found to contain besides the pyrite, a quantity of sulphur in minute crystals, almost as fine as powdered glass.

Many stories are told, of valuable discoveries in the past, along the line of strike of this belt north-east of the Tallapoosa River below the mouth of the Little River. But on investigation I could find but little reliable authority for such. No exposures of gold-bearing ore bodies can be found for examination; except on the property of

H. S. Bradley, Sec. 30, T. 19, R. 11 E., where a ridge, apparently formed from a conglomerate deposit, occurs. This conglomerate prospects colors, and apparently carries a large per centage of limonite. The extent of this mass is considerable, but the samples I tested, carried too small a value in gold to class it as pay ore.

There is one feature with regard to the formation of this belt, especially noticeable in the Goldberg District to

which I desire to call attention. It is the great abundance of limonite pseudomorphs after pyrite, (iron garnets) which are found imbedded in this semi-crystalline slate throughout the entire district. This is more noticeable though on the

Grizzle property, Sec. 24, Township 20, Range 9 E., where a line of demarcation between the slates and gneiss occurs. The surface is literally covered with these "garnets," some of which are very perfect specimens and quite large. At the time of my visit the lumps of slate, and slabs which are very thickly scattered over the surface; especially of one 40 acre tract, were being picked up, and piled to render plowing and cultivation easier. Nearly every piece of this slate contained several fine specimens of these garnets.

A vein of hard quartz, has been prospected a depth of 30 feet, this is bedded between decomposed slate and kaolin resulting from the decomposition of the feldspar in the gneiss. Near the surface some rich specimens, carrying free gold, were taken from this vein, which is however only 6 inches thick; but as sinking was continued the quartz carried much less value, indeed some of it, not even showing a trace of gold. At the point where this shaft was sunk the quartz appears to be interstratified with the gneiss and slate having its dip at an angle of about 45 deg. towards the S. E.

Resumé on the Goldville Belt.

I. The Goldville belt of semi-crystalline slates, from its extreme south-western boundary to the State line is nearly 90 miles in length, and of an average width of 6 miles; consequently its superficial era is nearly 540 square miles.

II. In the Upper Gold belt the prospecting has not been sufficiently extensive to warrant any definite determination as to value of occurrences of gold-bearing ore.

III. None of the openings except those on the Mitch-

ell property at Pine Hill, have been made in such a systematic manner as to enable us to figure on quantity of ore in sight, and probable permanency; or even determine definitely the structure of the ore bodies.

IV. The gold-bearing ores found on this belt in the Upper field, may be universally classed among the refractory ores, although some few exceptions may be found to that rule.

V. The prospects are good enough and sufficiently promising to warrant deeper mining in many places before any judgment should be pronounced.

VI. The gold cannot be saved by amalgamation on plates; neither will concentration after amalgamation prove perfectly satisfactory. Because the specific gravity of a percentage of fine gold found in the ore, as well as of a percentage of the sulphurets is not sufficient to prevent running water from carrying such particles away with the tailings.

VII. Direct chlorination of the ore after thorough roasting or possibly treatment with amalgamator and settler by Frazer and Chalmer's process, after roasting, may prove satisfactory, and result in profitable mining operations.

Assays as returned by Dr. J. H. Pratt of Birmingham.

Number of sample.	LOCATION.	Value in gold @ $20.67 per oz.	Value in silver @ 75cts. per oz	Total value per ton 2,000 lbs.
1987	Goldberg, Sec. 30, T. 20, R. 10	5.15	....	5.15
1988	" " "	3.14	....	3.14
1989	" " "	2.56	....	2.56
1990	Jno. Turner, " "	4.59	.08	4.67
1980	Bradford Fraction, Sec. 30, T. 20, R. 10	5.15	.08	5.23
1981	" Ridge " " "	5.15	....	5.15
1982	" " " " "	5.70	.15	5.85
1983	" " " " "	5.44	.22	5.66
1984	" " " " "	3.99	....	3.99
1985	" Fraction " " "	3.95	....	3.95
....	W. B. Mitchell, Sec. 1, T. 21, R. 9	9.81	....	9.81
....	Dr. Manning, Sec. 36, T. 20, R. 9	23.03	....	23.03
....	" " " " "	10.42	....	10.42
....	J. Walker, Sec. 29, T. 20, R. 10	5.37	....	5.37
....	Teakle, " " "	6.20	....	6.20
....	Bradford Ridge, Sec. 30, T. 20, R. 10	7.23	....	7.23
....	" " " "	7.75	....	7.75
2052	Teakle, Sec. 29, T. 20, R. 10	3.10	....	3.10

These assays were made on samples selected at haphazard, but with a view to obtain as near an average as possible, without sampling by the systematic quartering method; for which no facilities were afforded the survey.

MICA SCHIST GOLD BELT.

Location and General Characteristics.

Leaving the Goldville belt of semi-crystalline slate to the south-east, we cross the line of demarcation and into a region of gneiss and mica schist, which extends towards the north-west as far as the south-eastern foothills of the Talladega mountains. This region embraces an area of about 1,000 square miles, and comprises within its boundaries, portions of Coosa, Tallapoosa, Clay, Randolph and Cleburne counties.

This belt also contains two distinct leads of gold-bearing ore, so far as at present known. These may be designated as the Shinbone Ridge or Kemp Mountain lead, and the Pinetucky lead.

As the last named occurs to the south-east of the first my examination was resumed on that, after finishing my work on the Goldville belt.

With regard to this mica-schist formation, I found that it did not reach as far as the Alabama-Georgia boundary line. Its north-east extremity being Sec. 24, T. 17, R. 12, about 2 miles west of this boundary line. Here it terminates somewhat in the form of the narrow edge of a wedge, and is interstratified with the semi-crystalline slates in apparent conformity. Towards the south-west it widens out and attains its extreme width in the neighborhood of Pinetucky, in the north-western corner of Randolph county, where it is nearly 18 miles wide; extending from Rockdale, Randolph county, near the centre of T. 19, R. 11 E. to Chulafinnee, Cleburne county, Sec. 13, T. 17, R. 9 E.

Details of the Gold Occurrences.

Pinetucky Gold Mine, Sec. 12, T. 18, R. 10 E.—The

discovery of gold-bearing ore here was one of the earliest in Alabama, being co-temporary with the Arbacoochee Placer discoveries in the "forties." Some mining operations of a very crude character were carried on here about the same time that Arbacoochee was a prosperous typical mining camp. A volume of interesting reading could be written devoted exclusively to the early days of Pinetucky. Its changes of ownership have been numerous. Changes in the policy of the owners equally so. But up to the present time so far as I can ascertain from reliable sources, the results have invariably been partial or total failures. The blame rests to a very great extent on the shoulders of the management and owners, but not entirely so. Pinetucky is an example of what ought to be termed a rich specimen mine. The ore carrying gold is a narrow vein of hard bluish quartz, between equally hard mica schist walls. Both the gangue rock and ore are very tough and difficult to mine. The pay streak will average about 10 inches at the present depth of the workings about 60 feet vertically from the surface. Consequently the expense for mining under the most favorable circumstances, is in excess of what it otherwise would be. Add to this the fact that the vein is of lenticular or kidney structure, and the pay ore is found in chutes or chimneys, and the reasons for failures are quite intelligible, especially when the work is conducted by inexperienced miners, and mill men; as it generally has been. This mine presents some features I have not found existing elsewhere in Alabama.

The ore body, and formation have locally an abnormal line of strike; being nearly N. and S. with the dip to the east on a very slight incline not exceeding 10 deg. or 12 deg.*

Along the line of strike on the surface this ore body can be traced for a distance of about 1½ miles by the

*Subsequent careful observations of this ore-body, at a point very favorable for getting the correct dip and strike. show that the strike is N, 30 deg. E. and the dip is towards the S. E. W. M. B.

abandoned pits sunk in the past. The pits were sunk on the outcrop, and incline down with the dip of the ore body; the free milling or oxidized ore was mined out to water level then the pit abandoned, and a new opening made at the outcrop, to be mined out in the same manner, and in its turn abandoned. On the north and south granite veins outcrop with their lines of strike conforming to the general formation of the country N. E.—or only varying a few degrees from such a course. These veins carry mica in crystals of sufficient size to dress into sheets of commercial value.

As the vein of gold-bearing ore varies in thickness from a streak not much thicker than a knife blade, to 14 inches and sometimes exceeding that; so does it vary in richness from a mere trace of gold to the ton to $150.00 a ton. The values saved in the mill runs, in the ten stamp Fraser and Chalmers Mill erected some 5 or 6 years since, vary in much the same proportion as the assay values. One lessee claims to have saved $40.00 a ton from the ore, and $7.00 a ton from some runs on hanging wall rock. Another, that 100 tons of ore only yielded a total amount of $38.00 after costing $1,500.00 to mine. I have seen many specimens of the ore showing free gold in great splotches, and at one time I saw nearly 2 tons of ore mined nearly every piece of which was a fine cabinet specimen. I know myself of mill runs having been made which yielded $40.00 to the ton in free gold, but were limited to less than 4 tons to the run prior to a clean up.

A great deal of value has always been claimed to be carried by the sulphurets, with which the ore is heavily charged. It is impossible, however, at present to verify such a statement, because really no thorough system of concentration has ever been carried on.

Some concentrates sent to St. Louis in 1893 yielded according to Prof. Potter's assay $666.00 a ton in gold;

while other samples taken about the same time and presumably from the same pile only yielded $90.00 a ton, according to assay made by Mr. Makemson, Chemist for the Woodstock Iron Company, at Anniston. Some other samples sent to New York, a few weeks later, only assayed from $8.00 to $28.00 a ton, as returned by an assayer, for a new process for saving gold from concentrates called the "Kendall" process. Duplicates of these last were also sent to St. Louis, and the returns were approximately the same. Such results demonstrate that a very unsatisfactory method of concentration was practiced, or else that the samples were manipulated by some interested parties.

The workings in the mine to the east of the line of pits I have already referred to, consist of a vertical shaft 55 feet deep, and a drift on that level about 200 feet in length. Above this the ore has been mined out from the outcrop down; no attempt having been made to work ahead on the ore body and stope up. An incline some 10 feet in depth has been run with the dip of the vein from the bottom of this shaft, and this really represents the increase in depth in the workings for the past 20 years. In taking out ore about 6 to 8 feet of the hanging wall has always been mined out, and the pay ore streak is consequently at the floor of the drift, and almost invariably, even when mining was going on under water.

This system of mining is so crude, and unskilful, that there is no chance to estimate on ore in sight, because there is none. Had sinking been continued in a shaft located in the mill house, about 200 feet to the east of the shaft I have already described, until the ore body was cross cut, the conditions would have been very favorable for estimating the value of the property. This work would have opened up at least 200 feet of virgin ground, and reduced the cost of mining very appreciably;

by affording a chance to stope up instead of digging down for the ore, besides hoisting it directly into the mill over head, instead of using a steer and whim to hoist with, and a team to haul to the mill. The steam hoist being afterwards brought into requisition to place the ore on the rock breaker floor.

During the summer of 1895, and since my examination reported in the preceding pages was written, further prospecting work was performed at the Pinetucky Mine. This work was done with the aid of a diamond drill. The shaft in the mill house was bored to a depth of 205 feet without cross cutting any ore body. The cores from the drill showed granite at a depth of 55 feet, alternating with the garnetiferous mica schist country rock to the depth of 205 feet where work was abandoned.

A second drill hole was bored about 70 feet to the west of the mill house, and on a line between that and the old workings. In this mica schist was passed through to a depth of 60 feet, when granite was encountered, and to a depth of 130 feet the same conditions were found to occur as in the mill house. At this point work was abandoned, and a third hole sunk to the west. This hole is 80 feet east of the old working shaft. At a depth of 47 feet after passing through mica schist, the core showed granite was encountered. At a depth of 47 feet a 4 inch stratum of feldspar was passed through, and below that the core was ore, of much the same character as in the old workings. This, I am informed, was 12 inches thick. Next was four feet of soft gouge material, which was lost from the core, because of its softness. Below this a garnetiferous mica schist, similar to the country rock occurring in the old workings, was encountered for a few feet, and below that granite again showed in the core.

The Pinetuckey Company executed a lease to the Fair Mining and Milling Company, of Chicago, to extend over a period of five years. The lessees performed the

prospecting work with diamond drills, and after encountering the ore body in the third hole, commenced the work of sinking a working shaft at that point. This work is being carried on with dispatch. It is purposed to drift both to the north and south after cross cutting the ore body. Stopes will then be started, and the ore mined out to the old workings about 80 feet above, on the incline of the dip of the ore body.

I am informed by Mr. Hugh McIndoo, of Chicago, one of the lessees, that a thorough sampling of the mine in the old workings had been made prior to the prospecting with diamond drill. The assays showed an average yield of $38.00 per ton. Further tests showed that the ore was partially free milling. Some to the extent of 25 per cent., and others to 75 per cent. With regard to concentrating, I was informed by the same authority that such would result in the proportion of one ton of concentrates being obtained from 216 tons of ore.

No well defined extensions have been discovered, of this ore body, unless a discovery in a well on Sec. 13, T. 18, R. 10 E. should prove to be such. But no effort to demonstrate such a fact has been made; although the well was sunk early in 1893 by a negro, who showed quartz resembling Pinetucky ore, which he claimed he took out from the bottom of the well.

About two miles to the north of Pinetucky, the same country rock, underlying the granite veins, and conforming with their strike and dip, has been encountered; but no gold-bearing ore discovered.

To the south-west of Pinetucky on Sec. 13 the formation resumes its normal line of strike, as it also does a short distance N. E. of the workings; indeed such change occurs on the north half of Sec. 12, the gold mine being in south half of the same section.

So far as I am able to judge from the work performed, this is the most promising portion of Alabama for min-

ing for mica. Because in several locations to be described later in this report the crystals of mica are found of sufficient size and grade to warrant the assumption that profitable results would follow systematic and deep mining.

In a north-easterly direction from Pinetucky we find a break in the mica-schist formation, where the semi-crystalline slates appear in a wedge-like shape, with the thin edge towards the south-west. The line of demarcation on the southern boundary of this semi-crystalline is about 3 miles northward from Pinetuckey in T. 17, and the point of this wedge is in the same township near the Riddle's Bridge crossing of the Tallapoosa River in R. 10 E. being the same range as that on which Pinetucky is located. The northern or north-western boundary of this wedge of semi-crystalline formation, has a north-eastern course from the river to Sec. 17, T. 17, R. 11. Here the mica-schist again occurs; in its turn assuming a wedge-like shape with the thin edge at this north-eastern point, and widening out towards the south-west. At the Riddle's Bridge a junction is formed with the main body of mica-schist which formation continues to the south-west in an uninterrupted belt.

These complications of the formation are shown in a general way on the geological map of the State, where distinction is made, however, merely between the feebly crystalline Talladega slates, and the fully crystalline schists.

I will here continue my report on the occurrences of gold-bearing ore belonging to the north-westerly belt of mica, and hornblende schists of the upper gold belt and consider those belonging to the semi-crystalline slates later in order to avoid complications.

Crossing the Tallapoosa River from Pinetucky, in a westerly direction, I found that the Shinbone Ridge, which is a continuation on the western side of the river of that chain of ridges in which is located the Kemp Mountain which forms such a prominent feature of the landscape on the eastern side of the river, with its trend to the north-east towards Turkey Heaven Mountain.

This Shinbone Ridge with its trend south-westerly, crosses a portion of Cleburne county and Clay county. It bears much the same relation to that region as the "Devil's Backbone" bears to the lower gold belt. The geology though, of these two ridges is entirely dissimilar, for while the "Devil's Backbone" is made up almost entirely of semi-crystalline slates and hydro-mica schists, the formation of the Shinbone Ridge belongs to mica and hornblendic schists. For several miles this chain of ridges occupies an almost parallel position to the Blue Ridge Mountains proper, and near the south-western extremity the trend of both the mountains and the chain of ridges is in a southerly direction. The occurrence, of gold-bearing ore, which have been discovered in the belt of mica-schists, are located in what is known as the Idaho mining district, which embraces a large portion of T. 19 and 20, in R. 7 E.

The Idaho Mining District.

This district comprises several prospects, prominent among which are the Idaho, or Franklin, the Hobbs, the Laurel, the Chincapina, the California, and the Horn's Peak; on all of which mining operations of greater or less extent have been carried on.

The ore bodies in this district occur in the ridges, which make up the chain locally designated as the Delta Divide, which in this locality really embraces a mountainous district covering quite an extensive area, and

comprising several ridges or backbones lying almost parallel to each other; the most prominent being Shinbone Ridge. This belt of mica and hornblendic schists in which the gold-bearing ore bodies occur, is bounded on the north-west by a belt of altered eruptive rocks, locally termed "the copper lead," because iron pyrite, associated with chalco-pyrite has been found to occur in this rock, and mining work was carried on some years since in this locality.

The entire width of the gold bearing district which I refer to as "the Idaho District" is about three miles, and its length so far as, at present known about the same. On the north-western boundary is located a property known as the "Watts" which, in days gone by, is credited with having furnished a large amount of placer gold, and is particularly noticeable because of the vast quantities of large and well shaped garnets. So vast are the quantities of these that a portion of the property itself, is known as "Garnet Hill." Near this is a branch or small stream locally known as Gold Branch, which, history says, produced a large quantity of placer gold in the seventies. Another feature of the district is that in nearly all of the valleys formed by the creeks and branches, there occur beds of gravel at various depths below the surface which will nearly always yield placer gold from pannings. This fact has been demonstrated in several localities in this district by the cutting of ditches to drain the bottom lands.

The Idaho or Franklin, Sec. 3, T. 20, R. 7 E.—A ten stamp mill was run on the ore from this mine for several months a few years since; but work was abandoned because of litigation, and the mill and mine have remained idle since 1889, but will be started up in the near future, the litigation having been decided in 1895. The mine itself is on a ridge, locally known as "Gold Hill," which might be termed a foot hill of

the Shinbone ridge, on its north-western side. Open cuts made into the side hill expose an immense mass or deposit of quartzite and micaceous graphitic schist with decomposed material resembling wad interstratified, with the strata almost vertical. The strata are very thin usually, and so intermixed that it is very difficult to obtain samples of each material separate, so as to ascertain which carries the most value. The entire mass has been quarried, and I am informed was milled without any effort to separate the products of these strata. It is difficult to form any estimate of the extent or permanency of the ore body, because the work of mining was carried on without sufficient regard to future development. Apparently the strata continue on down indefinitely, and have been mined 50 feet wide. From the summit of the ridge to the floor of the cut at its lowest depth is probably 50 or 60 feet; and a shaft was sunk in the floor of the cut several feet. But as this was full of water I could not investigate the results obtained.

A very noticeable feature about the ore body is the immense quantity of iron-alumina garnets in the gangue. In fact the occurrence of these garnets associated more or less closely with the gold bearing ores of this district, is one of its distinguishing features. Such garnets do not carry any values, so far as can be determined by panning tests, but a test by fire assay might perhaps show the presence of some gold.

The formation at the Idaho mine is nearly east and west and the line of strike is maintained for two or three miles westerly. There are at least two distinct ore bodies on this property. The most extensive being that which I have just described with another but smaller body known as the "Little Sampson" vein; apparently entirely distinct from the main body, occurs on the north-west side, and a great change is noticeable in the character of the ore which carries values. For here the quartzite itself is

auriferous, and not the schist as is the case in the big or main ore body.

The work which was performed at the Idaho mine in 1888, resulted as I am reliably informed quite satisfactorily. I have during the spring of 1896, had a better opportunity to examine this property more closely than was afforded me during the summer of 1893-4, when most of my examinations on the upper gold belt were made.

Although of course the workings have caved in to a great extent consequent upon their being large open cuts and the number of years the mine has remained idle, yet I was afforded such an opportunity under the guidance of Mr. Joshua Franklin, superintendent of the property, as allowed me to inform myself more thoroughly relative to the extent and promise of permanency of these bodies.

The open cuts extend for 104 yards along the line of strike, and show that the ore body, where these cuts cross it, is at least fifty feet in thickness.* From pannings on an average of the entire ore body, in one cut, there is certainly a value of $2.00 a ton in free gold.

This value is more closely associated with the decomposed schist than with the bodies of quartzite, which have been exposed in the mine workings, but while this is the case, it is also a noticeable fact that the schist does not yield values except where closely associated with quartzite. Whether the garnets which occur as gangue yield any values, or not, is an open question.

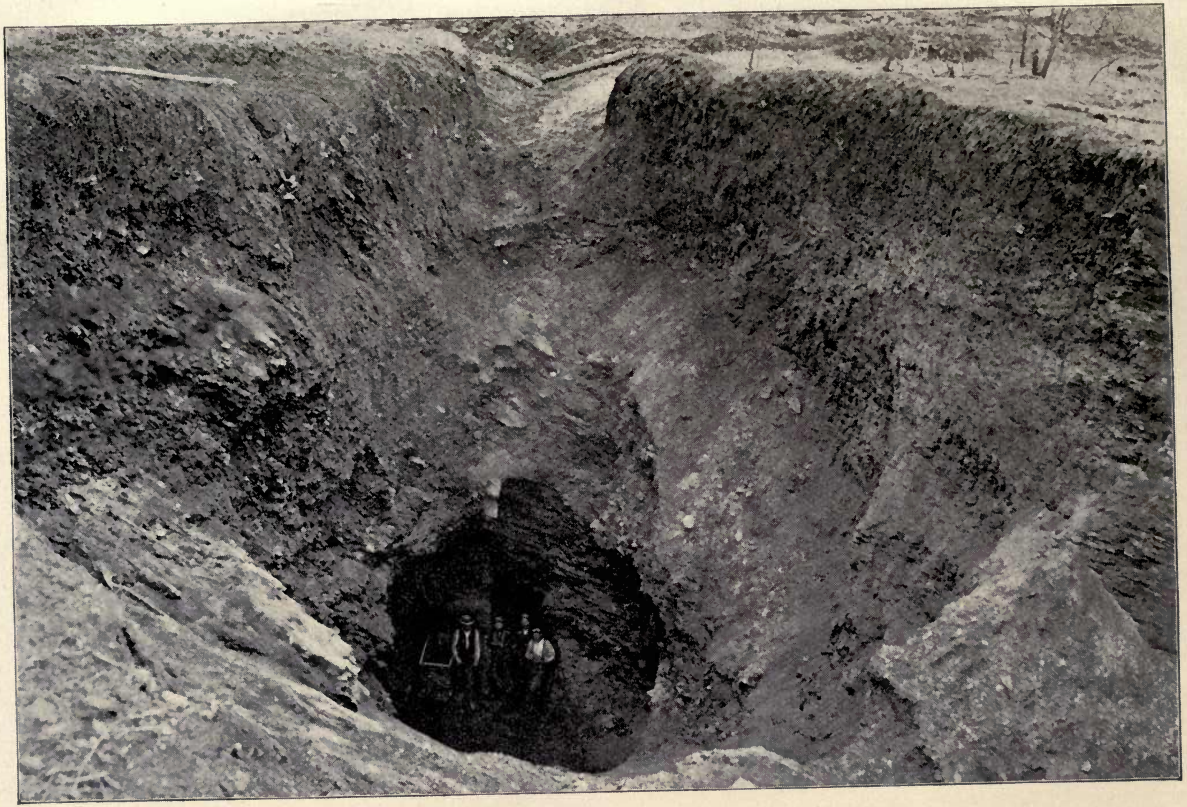
Some of the quartz bodies exposed in the main cut are fillers of fissure veins, cross-cutting the cleavage of the schists almost at right angles, and apparently maintaining continuity as greater depths would be attained. The dip of these is almost vertical, and the thickness has increased perceptibly at the floor of the cut, from the thickness at the outcrop, forty feet above. Mr. Frank-

* The accompanying plates illustrate the formation and structure of this occurrence of gold bearing ore. Plate No. I illustrates all the open cuts made into Gold Hill; the Stonewall cut, on the right, the Franklin in the centre and Nelson on the left. Plate No. II illustrates the Stonewall cut, showing the breast of the ore body with mouth of cross cut tunnel driven on a level with the floor of the cut. Plate No. III illustrates the Franklin cut showing conditions some what similar to those in Plate No. II.—W. M. B.

NELSON CUT FRANKLIN CUT STONEWALL CUT

IDAHO MINE

STONEWALL CUT, IDAHO MINE



FRANKLIN CUT, IDAHO MINE

lin, however, informed me that these quartz bodies carry but very little value, and indeed he did not consider such rich enough to run through the mill when he was working the property.

The second ore body on this property outcrops a distance of fifty yards north-west of the main workings. This is referred to earlier and designated as the "Little Sampson vein," and has been partially prospected, but the work has not been sufficiently extensive to warrant the expression of any opinion as to the material facts.

Judging from the line of strike of these ore bodies, a theory is tenable that if the continuity of each is maintained towards the other, the two bodies will intersect each other; because the line of strike of the main body is nearly due east, while that of the "Little Sampson" is several degrees north of east.

At the time of my recent visit, Mr. Franklin was making arrangements to resume active operations at the mine, and has been considering the advisability of adding a Huntington mill to the present plant, which is a ten stamp quartz mill. By doing this he expects to obtain relief from some unsatisfactory results he experienced before in treating the soft ore, which has such a clayey nature that in the stamp mill it chokes the screens and interferes materially with the crushing capacity, as well as with amalgamation, when quick silver is fed into the battery.

It is highly probable that this new plant will be running on the Idaho ore before the first of July, 1896; and the owners propose, as I am informed, to operate the property as a permanent investment, and with the expectation of developing it into a dividend paying mine.

Following this ridge to the south-west from the Franklin mine, I found its surface was thickly covered with pieces of quarzite, in which are embedded masses of gar-

nets, as well as pieces of limonite, closely resembling gossan. This is characteristic of the mica-schist belt, and proved an incentive in years gone by to encourage many men to prospect quite extensively for copper ore; but in this section almost invariably without success.

The Laurel, Sec. 4, T. 20, R. 7.—The ore body exposed by shallow prospect holes on this property is apparently an extension of the Little Sampson. The line of strike though is nearly east, with the dip almost vertical, and the ridge on which this is located is an extension of the Franklin or Idaho ridge. Its continuity, though, has been interrupted by some small creeks or branches which have cut channels through it as they flowed towards Talladega Creek, into which they empty.

The character of the ore is very similar to that found in the Little Sampson; the values being found almost entirely confined to the quartzite, which can be more easily separated from the decomposed matter resembling wad and schists, than at the Idaho. Samples taken from the entire mass pan very satisfactorily; and during the summer of 1893 a miner named Stevens made fair wages sluicing the vein stone from the Laurel without first crushing it,—proving by that result that the gold is disseminated through all the material forming the vein stone of the pay streak, which is about four or five feet wide.

Work on this property has been insufficient to determine any facts, beyond showing it to be a good prospect. Mr. Steed, the owner of the Laurel, informed me he proposed, during the present year, to prospect that ore body at depth, by a cross-cut tunnel, which can be easily run from the base of the ridge so as to intersect the ore body at a depth of 50 or 60 feet below its outcrop.

A stream flowing near the base of this ridge, and having its source in the ridge, will furnish ample water for mining and milling purposes. Also for hydraulic min-

ing should the gravel bars along its bed prove of sufficient extent and value. These have been worked by sluicing, at irregular intervals, for some years past, and in spots are quite rich.

The Chinca-Pina, Sec. 33, T. 19, R. 7 E.—This prospect is located on a ridge to the north of that on which the Laurel and Idaho occur. The line of strike of the ore body is North-east with its dip towards the S. E. at an angle of about 30 degrees. The workings consist of an open cut, crossing the formation ; an incline pit or shallow shaft, and several shallow holes in which the surface soil pans very satisfactorily. These last, though, have not been sunk deep enough to expose rock in place.

The openings have been made in such a manner that no reliable estimate as to value, or permanency, or extent of the ore body can be formed. The ore is found in strata bedded conformably with the formation, having no well defined walls. The pay is disseminated through these strata in the same manner, as in the more vertical strata on the Idaho and Laurel.

Hobbs, Sec. 3, T. 20, R. 7 E.—This ore body is located on a ridge extending almost parallel to but between the ridges on which occur the Chinca-Pina and Laurel. It has been exposed in several shallow pits, and is apparently a promising prospect.

California, Sec. 15, T. 20, R. 7 E.—On this property a ten stamp mill was erected some years since. and mining and milling operations conducted. But the openings were all caved in at the time of my visit, and I was unable to explore them. Beyond the fact that the ore found in the mill, and around the old dumps, yielded prospects by panning, nothing further can be said about the property.

The Horn's Peak, Sec. 4, T. 20, R. 7 E.—During the

summers of 1893 and 1894, when I made my first examination of this district, this ore body had been but very imperfectly prospected at the summit of the peak or hill from which the mine takes its name. But at this writing , spring of 1896, a recent visit to this district, has enabled me to examine the property more thoroughly, because a considerable amount of work has just been performed and several tons of ore milled in a small five stamp mill located in the vicinity.

While this peak is really a continuation of the ridge in which occurs the ore body in the Idaho mine; it is separated from the main ridge by erosion. This ore body is located almost westerly from the Idaho mine and not quite a mile distant.

A cross-cut tunnel has been run to intersect the ore body at a vertical depth of about twenty-five feet from the summit of the peak. This work has demonstrated that the ore body is some thirty feet in thickness and several runs of a limited quantity of average ore through the mill have resulted, I am informed, in a saving of $2.00 gold per ton, by amalgamation. The ore may be styled as a garnitiferous quartzite, because of the large quantities of iron-alumina garnits embedded therein.

No work to determine the continuity of this ore body along its line of strike other than shallow prospect holes along the summit of the peak, has been yet performed. Nor has any deep work been attempted.

From the structure of the peak it would have been very easy to determine the permanency and extent of this ore body at depth of about 200 feet, by merely running a cross-cut tunnel to the ore body, and drifting along the line of the strike. Such work would be doubly advantageous too, because it would have drained the mine as well as have afforded a splendid opportunity to mine the ore by stoping. The value of the property too, would have been demonstrated beyond cavil, because it would have been

an easy task to measure the quantity of ore in sight and make calculations on which the value of the property should be based.

Kemp Mountain District.

Eckles, Sec. 23, T. 17, R. 10 E.—No other discovery of gold-bearing ore has been made to the north-east of the Idaho District in the mica-schist formation on the west side of the Tallapoosa River, so far as I was able to ascertain, either by prospecting or from reliable information. After crossing the river towards the east I found prospects in many of the branches and creeks, especially on the Denman and Morrison plantations to the west of the Eckles property. But no work of any extent exposing pay ore had been done.

The Eckles property has created quite an excitement from time to time since its discovery in the spring of 1893. It was bonded during that summer for $30,000. The 40 acre tract of land on which it is located was purchased by an old prospector named Eckels for $125.00, after he had done some prospecting, the result of which was not generally known. The same tract had been offered previous to that time for a Texas pony worth about $40.00.

The prospect work consists of an open cut, crossing the formation, with a shaft some 65 feet in depth, below the floor of the cross-cut, which is about 8 feet deep. This cross-cut is nearly 50 feet in length and exposes the ore body almost that entire distance. In structure this ore body bears great similarity to those in the Idaho District; being a series of thin vertical strata of quartzite and decomposed schists, so closely interfoliated that it is difficult to obtain samples to determine which strata carry the pay. Samples taken from nearly any portion of the cross cut will yield good results without crushing

the vein stone. In sinking the shaft the strata were found to maintain their vertical dip to a depth of 36 feet, here the dip changed to an angle of about 60 deg. towards the south.

A cross cut run at the bottom of the shaft showed the ore body which yielded pay, had narrowed down to 18 feet in thickness, much of the decomposed material found at the surface having apparently pinched out, leaving the strata of quartzite more concentrated. During the summer of 1894, sinking was continued on the shaft until a depth of nearly 100 feet had been attained, without any material change having occurred in the ore body.

The surface has been prospected across the 40 acres on the line of strike of the ore body, which is slightly north of east, and its continuity demonstrated. The same results were obtained on the extreme western border of the tract, but beyond this the formation has been folded several degrees to the north, and although continuous, does not yield pay where some shallow prospecting has been done on the adjoining tract.

No systematic work of treating this ore has been done, by which an average value from mill runs can be estimated. The graphite interferes with treatment by ordinary amalgamation, and the absence of sufficient water prevents working the property by hydraulic process, and afterwards milling the quartzite tailings, as is done at Dahlonega, Ga., on a somewhat similar formation.

Such a method of mining and treatment could be carried on profitably to a depth at any rate of about 40 feet; but below that the vein stone becomes very much more solid and will probably become sulphuretted near water level.

Golden Eagle, Sec. 17, T. 17, R. 11 E.—This property was originally known as the old Price mine, and pros-

pecting work consisting of two incline shafts, one about 30 feet, the other shallower, together with about 100 feet of tunneling was performed in 1893. This work was done by some parties who held an option on the property, which however expired before any very satisfactory discoveries were made. Since then and during the spring and summer of 1894, work has been resumed by W. D. Vaughn of Heflin. Under his management an upraise was made from the tunnel to the bottom of the deepest incline shaft, and a drift some 30 feet long was run on a level with the point in this shaft (32 feet from the surface) where work was discontinued in 1893. From the discoveries made by a prospector in the spring of 1894, the first miners had quit work on the eve of exposing some very rich ore. As much of this carried free gold, visible to the naked eye, and assayed as high as $58.00 a ton, Mr. Vaughn took an option on the property and went to work at once to develop it further. He is also erecting a small stamp mill for the purpose of prospecting and sampling, that portion of the ore body which is free milling. Such is apparently the character of the ore to a depth of about 30 feet, but below that depth it can only be considered partially so because the ore is not only very highly sulphuretted, but also has the appearance which denotes that it carries a large per centage of arsenical pyrite. The deep shaft is now about 75 feet in depth, sunk on the ore body with the same incline as the dip; an angle of 50 deg. towards the south-east. The line of strike is N. E.

The vein matter consisting of quartzite and hydro mica schist is about 10 feet thick at the 75 foot level. This vein of quartzite is very much decomposed, and enclosed between what appear to be semi-crystalline slate walls, being the same character of slate as forms Turkey Heaven Mountain, which are not well defined near the surface. This occurrence of gold bearing quartzite is

almost at the extreme point of the strip of mica schist formation, which forms the northern prong of fully crystalline rocks in Cleburne county. A vein of coarse grained granite is also exposed in this formation, about 50 feet south-east of the ore body I have referred to, and which should be designated as the "lower" body, because on the south-east side of the granite vein another, and distinct ore body has been exposed. This outcrop occurs paralleling the vein of granite, which is about 30 feet thick, and in apparent conformity with the general formation, both with regard to strike and dip. In fact the series occur on the surface as follows: On the north-west, the "lower" ore body, about 5 feet thick at the surface, bedded in slate much decomposed near the surface; next in order, towards the south-east, Turkey Heaven Mountain slate 50 feet; next granite vein about 30 feet in thickness, then the mica schist in which is bedded the "upper" ore body. In this ore body the gold is carried by a sandy, sugary, friable quartzite; and considering that in 18 feet, (the depth of the incline), this ore body has increased in thickness from 6 inches at the outcrop, to 2 feet at the bottom of the shaft, it is certainly a promising prospect.

In the tunnel on this property, beyond to the south-east of the point where the "lower" ore body is cross cut, an upraise was commenced by the miners who first drove this adit. In this I find that the formation above the ore body is a pyritiferous graphitic slate very hard and similar to the slate forming Turkey Heaven Mountain it is very tough on this level, which is 50 feet vertically below the mouth of the incline shaft.

The granite vein referred to apparently is intrusive, because at a point about 300 yards from the mine workings, and to the north-east we find it is only 3 feet thick at its outcrops, which resembles a big boulder, but is continuous towards the south-west; though apparently

not so to the north-east, so far as the surface indications show.

The slate country rock which forms the hanging wall of the "lower" ore body belongs to the Turkey Heaven Mountain series, but that forming the foot walling has more the appearance of a hydro-mica schist, than the typical "Talladega" or semi-crystalline slate, found covering such an extensive area north-west of the Arbacoochee Gold Mining district, and extending to the south-eastern border of the Paleozoic area.

Traveling in a northerly course from the "Golden Eagle" or "Price" mine we find this hydro-mica schist extends for about 1½ miles. Beyond that point and northerly the geology is difficult to determine, because the surface of the ground is covered by pieces of quartz and soil with no exposures of the slate, until the north-east corner of section 9, township 17, range 11 E. is reached, where a narrow strip of hornblendic rock (diorite) occurs. Beyond this again in a northerly direction we find no exposures of the slates until after crossing the Arbacoochee and Bowden wagon road near the western boundary of section 34, T. 16, R. 11 E. where the typical "Talladega" slate occur.

**Results of Assays by Dr. J. H. Pratt of Birmingham, Ala., from samples taken at haphazard along the Mica-Schist Gold Belt.*

2053 Chinea Pina, Sec. 33, T. 19, R. 7 E. $1.38 per ton gold.
2062 Pinetucky, Sec. 12, T. 18, R. 10 E. $89.91 per ton gold.
2063 Geo. Hobbs, Sec. 3, T. 20, R. 7 E. $4.55 per ton gold.
*2064 Price "lower" body, Sec. 17, T. 17, R. 11 E. $2.75 per ton gold.
*2065 Price "upper" body, Sec. 17, T. 17, R. 11 E. $2 07 per ton gold.
2070 Laurel, Sec. 4, T. 20, R. 7 E. $77.10 per ton gold.
2004 Franklin, Sec. 3, T. 20, R. 7 E. $14.26 per ton gold.
1978 Eckles, Sec, 23, T. 17, R. 10 E. $8 58 per ton gold.

*Taken from old workings previous to resumption and new work.

"TURKEY HEAVEN MOUNTAIN" OR NORTH-WESTERN SEMI-CRYSTALLINE SLATE BELT.

Gold Ridge Mining District.

This district is located in T. 17 and 18, R. 12 E. apparently in the semi-crystalline slate formation, near the line of demarcation between the mica schist belt and the slates. In fact it is immediately to the south and east of the point where the mica schist wedges out, two miles from the Alabama-Georgia line in Cleburne county to which I have before referred.

In some respects the occurrences of gold bearing ore in this district may be considered properly to belong to the Goldville Belt; for although the formation is composed more extensively of the slates found in Turkey Heaven Mountain, a graphitic variety of semi-crystalline slate interstratified with the regular semi-crystalline varieties, than is found elsewhere on that belt; yet it is really the same, when the formations are only classed as crystalline and semi-crystalline.

I can not identify the ore bodies on their lines of strike with any in the same formation to the south-west, and for that reason as well as because of the slight difference in the country rock, I have considered this district as distinct from the Goldville Belt. So far as at present prospected the quartz seams in this district rarely carry any values. The ore which yields value is a ferruginous sandstone, but several very fine specimens of sugary quartz, impregnated with free gold are reported to have been found in this district, a few years ago. Several of these I was shown by Mr. Charles Harper of Rome, Ga., who is a part owner in about 1,600 acres of land in the neighborhood. The only prospecting work of which I could

obtain any knowledge has been done on this property, which comprises portions of Secs. 27, 33, 34, T. 17, R. 12 E. and Secs. 3, 4, 5, 7, 8, T. 18, R. 12 E.

I could not ascertain the exact location of this prospect work by section number, nor could I, when I examined it, determine any essential points relative to the ore body. A shallow incline shaft had been sunk exposing a body of ferruginous sandstone about 20 feet in thickness, having its line of strike nearly Northeast and dip about 45 deg. to the S. E. Samples taken from the dump panned in free gold satisfactorily, showing some $4.00 or $5.00 a ton; but the ore body itself could not be sampled because of water filling the shaft. I was informed that the entire thickness averaged as well as the samples I tested. It is claimed, work was abandoned because of the water rising in the shaft, and the owners were not in position to provide pumping facilities. Really the property was purchased for speculative purposes, and the only object of the owners appears to have been to expose an ore body, and make no attempt to develop it.

The property was purchased with the view of controlling as much as possible of the lead longitudinally, and, if development should prove that continuity along the line of strike is maintained, together with values, and continuity at depth, then this will be a valuable property. But such can only be determined by actual work, which at present has not been performed.

An analysis by Dr. Pratt showed $4.82 a ton in gold from samples taken from the dump I have referred to.

Turkey Heaven District.

From the Gold Ridge property I followed the line of demarcation between the semi-crystalline slate and mica schist towards the south-west, to the point where the

slates wedge out near Riddles' Bridge, and prospected back to the north-east in the semi-crystalline formation. In this region are located the Turkey Heaven Mountains, from which the mining district derives its name.

I found that gold bearing ore occurred at several locations at and near the base of these mountains, but none has yet been discovered in the mountain itself. On its summit and sides, as well as in the formation to the south-west, the graphitic variety is interstratified with the Talladega, and other semi-crystalline slates, and all of the occurrences of ore carry a large percentage of this graphite.

Miller, Sec. 35, T. 17, R. 10.—This is the most south-westerly discovery of gold bearing ore in this Turkey Heaven District. It is located only a short distance from the point where the slates wedge out, and are displaced by mica schist.

A few shallow prospect holes have been sunk, and a body of sandstone exposed, a portion of which carries gold. This ore is found to occur under a limonite capping, and I could find no evidences of well defined walls to indicate vein structure. The barren, and value-carrying ores appear to be interstratified, and form a deposit, with its dip towards the south.east, and on only a very slight incline.

The work has been insufficient to base any estimates as to value of the prospect, but the indications point to there being a large deposit. I base this opinion on the showing in a number of shallow prospect holes sunk along the line of strike and from the outcroppings, which prospect some colors.

Crown Point, Sec. 19, T. 17, R. 11.—To the north-east of the Miller property about 2 miles distant, considerable work has been done, and a five stamp mill erected on the Crown Point mine. No systematic mining has been done here, although a small quantity of ore was run

through the mill in 1893. But the value saved was insufficient with such limited crushing capacity to produce profitable results. Consequently work was abandoned, before the value of the prospect, or extent of the ore body was determined.

A sample assayed by Dr. Pratt showed $3.23 in gold a ton. From this property the leads of gold bearing ore apparently follow the flanks of the mountain, one on the south-eastern and another on the north-western. Along the southern flank but little prospecting has been done, and such failed to expose any promising prospects. The work though was quite limited in extent, and if pursued systematically may yet result in the discovery of gold bearing ore bodies.

Moss-back, Sec. 35, T. 17, R. 11 E.—This was one of the early gold discoveries, made during the copper excitement early in the "seventies." The outcrop and ore near the surface yielded very fair results, as I am informed on reliable authority; but deeper mining operations appear to have resulted disastrously, judging from the fact that both mine and mill have been deserted for years.

Two incline shafts were sunk on the lead of ore, one exposes an ore body 8 feet thick bedded between walls of a talcoid graphitic schist, or decomposed slate, resembling schist in appearance; the other an ore body 18 inches thick, bedded in the same country rock.

The last mentioned, was known as the "Houston" shaft, and I am informed the ore taken from it yielded by mill runs from $4.00 to $4.50 a ton in free gold. The first mentioned, was known as the "Company Shaft." This was considerably deeper than the "Houston," being some 30 feet. The ore taken from it was of lower grade than from the other, but the cost of mining the thick ore

body was of course less than the thin; which ought to have offset the difference in value.

A vertical shaft was sunk, with a view to cross cut the ore body exposed in the "Company" shaft at greater depth. While the work was progressing, I am informed, that the superintendent reported that the gold bearing ore had given place to copper bearing ore. He shut down the mill, and abandoned mining operations at once, and the same condition of idleness exists to-day. I was unable to explore the workings because of water, so can not verify my information by a personal examination.

A good ten stamp mill was erected on this property in 1890, and for several months quite extensive mining and milling operations were conducted.

Pritchard, Sec. 36, T. 17, R. 11 E.—Here an incline shaft some 15 feet deep, has been sunk for prospecting purposes, and about 7 feet of strata of auriferous sandstone, or quartzite has been exposed. This is bedded between talcoid graphitic decomposed slate or schist walls, with a slightly inclined dip towards the south-east, and its line of strike nearly north-east. By panning an average sample from the entire thickness this proved of low grade, about $3.00 a ton; but by selecting samples some very rich results were obtained.

Lucky Joe, Sec. 25, T. 17, R. 11 E.—This property is located to the north-east of the Moss-back and nearly north of the Pritchard, distant about three-quarters of a mile from either. Although, at the point that active mining operations were carried on in 1893, the formation on this property is contorted from the normal line of strike North-east to an abnormal line nearly due north yet I am inclined to class the Moss-back and Luckey Joe as belonging to the same lead of quartzite. Although I have never actually followed the outcrop of the formation, from location to location, yet the evidence of folding by lateral pressure is so well defined, by the crooked lines of the strike of the slates

on the Luckey Joe property, and the resemblance in the ore so marked, together with that of the country rock, that I feel convinced development will prove the correctness of my theory. But I doubt very much if the lead, should its continuity so far as formation is concerned be proven, will maintain any continuity so far as being gold bearing, is concerned.

Development in the Lucky Joe has already demonstrated that the pay ore is found in chimneys or shoots in the ore body. The property was first opened in 1893 to a notable extent, and a ten stamp Fraser and Chalmer's mill erected thereon, with all the latest improvements. But as it proved later, the management had committed the fatal mistake of erecting this plant before the property was sufficiently prospected to prove that a mine actually existed. Consequently the first clean up was not satisfactory, and all work was abandoned for several weeks. Later, after more extensive prospecting, other mill runs were made, which proved more encouraging; having demonstrated that $2.27 a ton could be saved in gold, by amalgamation. The cost of mining and milling, I was informed by the Superintendent (an experienced miner from Colorado) was $1.35 to $1.45 a ton. The capacity of the mill using 30 mesh screens, being 30 tons a day, together with the other facts I have mentioned, insured profitable results from mining and milling, provided that sufficient quantity of ore of that grade could be mined.

During the summer of 1894 I made a thorough examination of this property, because the success or failure were matters of vital importance to the gold mining industry of the state; and I wanted to determine, if possible, whether, in spite of partial failure due to the mistake made at the commencement, the condition of the property was such as to indicate future successful results.

I found, as I have already stated, that the pay ore lay in chimneys or shoots, which occurred through the so-called

ore body, of varying width and thickness. Therefore, while the vein matter is apparently quite extensive, yet only a limited portion carries values; consequently, during the first milling operations a large number of tons of barren material, having the appearance of pay ore, were milled. This, of course, reduced the yield of the ore itself to an insignificant figure.

The vein matter is a garnetiferous quartzite interstratified with a decomposed talcoid slate or schist, and by panning I ascertained that sometimes the value is in the quartzite, but more often the decomposed material pans the richest. The workings consisting of 300 feet of drifting and cross cutting show that the chimneys of pay ore are about four feet wide and three to four feet thick, dipping towards the east on about a 30 degree angle, with their line of strike a few degrees west of north These ore shoots lie almost parallel to each other, and up to the time of my visit three of them had been exposed. The centre one of these is wider than the others, and apparently the main channel, towards which the narrower shoots appear to be trending. The work being done at the time of my visit was to determine whether these shoots did actually concentrate to one main body of pay ore. A winze was being sunk from the 50 foot level, on which all the prospecting has heretofore been done, to determine the extent and permanency of the widest shoot at a greater depth.*

Smith and Wood's Old Copper Mines.—Paralleling the Pritchard ore body on its western side occur the old copper mines, worked in the early "seventies" I can only refer to these from information I could gain in the neighborhood, because all work has been abandoned for several years past, and the openings made at that time are all full of water to-day.

It is a matter of history that both these properties produced considerable copper 20 years ago. The ore was smelted in soapstone furnaces, the ruins of which still remain as land marks. This soapstone was quarried near by, from a ledge which occurs in the neighboring crystalline formation.

* A few weeks after my visit work was suspended again, and has not been resumed since to date, April, 1896.—W. M. B.

From the appearance of the water flowing from the old workings, the mines were evidently not entirely worked out, because scrap iron will precipitate copper in short time, and in considerable quantities. Some of the ore must evidently be fairly rich. From the most reliable information I can gather, the work was abandoned because of the average low percentage of copper, and excess of iron pyrites. The ruins of the plants, old dumps and general appearance of the surroundings indicate that quite extensive operations were carried on during the days of copper excitement. Between this group of mines and the state line to the north-east no occurrences of gold-bearing ore have been discovered.

Leaving the neighborhood of this group of mines, and traveling towards the north-west across the thick edge of this semi-crystalline belt, we cross the eastern flank of Turkey Heaven Mountain. No discoveries of any importance of gold-bearing ore have ever been made, until Section 2, T. 17, R. 11 E. is reached. We pass the

Head Mine, Sec. 13, T. 17, R. 11 E., on which considerable work was done a few years since, without resulting in any discoveries worthy of note, and I only mention it in this report to show that in my examination I have not neglected to notice any properties on which discoveries are claimed, or prospect work of any extent performed.

Hall, Sec. 10, T. 17, R. 11 E.—Some shallow prospect work has been done on this location, but such was not attended with any promising prospects being discovered, and is mentioned for the same reason.

**Hicks-Wise, Sec. 2, T. 17, R. 11 E.*—A greater vertical depth has been reached in the workings in this mine, and a more extensive ore body disclosed than at any in Alabama at the present period. A shaft, almost vertical, has been sunk 110 feet, or 27 feet below water level. About 3,000

* The present period referred to is the summer of 1893.—W. M. B.

tons of ore have been mined and milled from levels run from this shaft, at 20 feet, 40 feet and 85 feet from the surface. It is claimed that this ore yielded $2.00 a ton by amalgamation. It can hardly be classed as free milling ore, although no other treatment has been attempted. Because of the percentage of graphite it carries from the surface down, and the sulphurets below water level, amalgamation will never save full values.

The line of strike is Northeast with an almost vertical dip towards the S. E. The structure of the ore body can hardly be considered as determined. In the soft decomposed slates from the surface to water level, it has all the appearance of a mass of ferruginous sandstone, quartz and decomposed slate with the appearance of a stratified deposit of unknown depth, and width. At the 85 foot level (the deepest work I could examine, because of water and no pumping facilities), this ore body has been drifted on a distance of about 200 feet, and maintains its continuity; but at no point has it been cross cut to determine its extreme thickness. Both headings of the drift are in ore. A cave which occurred near the surface, shows a thickness of ore 25 feet, but whether that is the maximum can not be determined.

Assays on the Hicks-Wise I am informed by Mr. Julius Houston of Arbacoochee, show its value to increase from $2.00 a ton at the surface to $14.00 at 110 feet, at which point the sulphurets ran as high as $39.00 a ton. These assays I was informed were made by W. M. Courtis a mining engineer and chemist of Detroit, Mich., who made an expert examination of the property in 1893. Other assays are given below.

Lee Mine, Sec. 2, T. 17, R. 10 E.—This property was purchased in the spring of 1894, by a syndicate of capitalists from Cincinnati, and extensive prospecting work commenced.

The line of strike of the formation and ore body is Northwest with the dip slightly W. of S. at an angle of 45 deg. It has all the characteristics of a bedded vein be-

tween slate walls, which are well defined, better in fact than at almost any location I have examined in the State. The varying thickness of ore in a drift at 40 feet from the outcrop, on an incline conformable with the dip, is between 4 and 5 feet. An incline shaft has been sunk about 40 feet, from the surface down with the dip, where a cross cut tunnel from the south side of the ridge in which the ore body is located, intersects the bottom of this shaft. A drift 121 feet in length has been run on this level, in ore the entire distance, with ore in both headings, and nearly 80 feet of the drift showing the ore body to maintain its continuity at its maximum thickness. From the level of this drift an incline has been sunk 20 feet, showing the ore body to be 5 feet 6 inches thick at the bottom.

The plant at present in operation for treating this ore comprises three arastras, and a Blake crusher. The superintendent, Mr. S. Fehr of Cincinnati, informs me that by this treatment, he has demonstrated that the ore will mill $5.00 a ton in gold.

A fair average sample I took myself from the entire thickness of the vein as exposed at 15 feet deep assayed by Dr. Pratt of Birmingham, yielded $12.61 a ton in gold. The thickness of the vein at the point from which I took my sample was 2 feet 6 inches.

Crumpton, Sec. 7, T. 17, R. 12 E.—The occurrence of gold bearing ore discovered on this property, has not been prospected sufficiently to determine whether any ore body beyond the mass of outcrop, and irregular "blow out," as it may be termed, really exists. The ore is the same ferruginous quartzite, in the "Talladega" semi-crystalline formation, as that occurring in the Lucky Joe and Mossback; but the country rock shows less of the graphitic variety of slate than that in which those mines occur. However, as the line of strike on the Crumpton has its normal trend Northwest and the property is located on a

direct line geographically, with those mines I have mentioned, I believe I am correct in classing it as a possible extension, subject of course to determination by actual prospecting. Some of this ore pans very richly, especially that from some strata which are less ferruginous than the bulk of the ore.

Middlebrook, Sec. 3, T. 17, R. 12 E.—This property is located in the north-east corner of the north-west quarter of the section. The ore body is interstratified with the formation, having its strike North.east and dip South-east conformable with the country rock, the same "Talladega" semi-crystalline as is typical of this section of the gold fields. The ore is a ferruginous quartzite, and the body is capped with limonite. An incline shaft has been sunk about 20 feet deep showing a thickness of pay ore nearly 5 feet; from which I obtained not less than $5.00 a ton in gold, by panning an average sample taken from the entire thickness.

Ballinger, Sec. 2, T. 17, R. 12 E.—An occurrence of gold bearing ore, similar in character and at the outcrop of about the same relative value from pan tests as the ore found on Crumpton property, about 3 miles S. W., was discovered on this property several months since, but no attempt to develop or even prospect the outcrop has been made.

Sutherland, Sec. 34, T. 16, R. 12 E.—Here a body of gold bearing quartzite has been quite extensively prospected. This ore body, while bearing in some particulars, as to the stratified structure, a close relationship to the Middlebrook, yet may prove by development to be confined between well defined walls. Certainly it has a well defined slate hanging wall, but no solid foot wall has been yet exposed, unless a stratum of decomposed slate, should prove such. The slate hanging wall has faulted at the depth of about 30 feet below the surface, and threatens to cut off the ore body entirely, in one incline shaft sunk on an incline of about 45 deg. to a depth of 30 feet. At this point the fault in the slate was encountered and work suspended. The ore body had main-

tained a thickness of nearly 4 feet above this, and prospected very satisfactorily.

There are two other incline shafts, one 25 feet in depth, the other 15 feet.

The deepest of these two exposes nearly the same thickness and grade of ore, as in the first shaft mentioned. But in the more shallow pit, two bodies of ore which at the outcrop, near the pit, appear divided or separated by strata of decomposed slate have united, and the body of quartzite has an aggregate thickness of nearly 12 feet. But what proportion of this yields values I am not prepared to state.

Ore from this property has been milled in a temporary stamp mill constructed of wood throughout; except clumsily made iron shoes. The stamp stems are made of 4 in. x 4 in. scantling. The cam shaft, a log squared, about 12 inches through. The cams are cut, with great ingenuity and fastened into this log. The tappets were wooden pegs set in augur holes bored through the stems.

The results from milling in such a primitive manner, would hardly prove a fair test of the ore; even if such could have been obtained, which I found impossible.

Bennifield, Sec. 27, T. 16, R. 12 E.—This property has been prospected by several shallow open cuts, exposing the occurrence of gold bearing quartzite. This has every indication of being a stratified deposit, covering considerable area of undetermined thickness. The ore would be classed as low grade, so far as my tests by panning, without taking a sample in a thoroughly systematic manner, could be relied on. Some other shallow prospecting has been done in the neighborhood, but not sufficient to base any estimate on as to extent, value or permanency. More extensive work should be done, before any determination as to the value of any of this district can be arrived at. In fact the same proposition applies to the entire State so far as gold mines are concerned.

Marion White, Sec. 6, T. 16, R. 12 E.—In this same "Talladega" slate formation, and to the north-west of the quartzite bodies just referred to, and within a short distance of the Georgia Pacific Railroad in Cleburne county, occur a few prospects, which are promising enough to warrant the performance of more work than has already been done. The most important of these discoveries is on the Marion White property, over which in 1893, there was considerable excitement because of some quite rich quartz specimens being found in which the free gold was visible to the naked eye. These were found as float. Prospecting exposed a thin vein of quartz with lenticular structure bedded in the slates, which also panned fairly well. But a sample which was assayed by Dr. Pratt only yielded $2.27 a ton in gold. The work was not of sufficient extent in the neighborhood to warrant the expression of an opinion.

James Moore, Sec. 12 and 13, T. 16, R. 10 E.—This property is some 6 miles south-west of the White prospect. Placer mining of considerable extent was carried on in this neighborhood as well as on this particular property some years since. Sluicing in a ditch recently yielded some fairly coarse particles of gold quite rough, and ragged on the edges, denoting it had not been washed far. But for placer diggings the ground would not pay, and some little surface prospecting failed to expose any quartz body or vein bearing gold. Indeed, although the surface of the ground, through several properties in this settlement, is plentifully covered with float quartz, decomposed and porous to some extent, and plentifully stained with iron oxide, yet no ore body, or outcrop or even float carrying gold could be discovered.

Resume on the North-western Semi-Crystalline Belt.

I. The extent of this belt so far as the formation is concerned, and not including the Terrapin and Talladega Mountains, which, while the formation is the same, I shall treat separately, because the ore bodies in these mountains occur

on the north-west slope, and consequently really belong to a separate and distinct belt, is about 18 miles long with the line of strike, and 24 miles wide across the formation at its widest part, and contains about 300 square miles.

II. The ore through the entire belt is a sandstone, or ferruginous quartzite, which were it not for the presence of graphite, and sulphurets below water level, might be classed as free milling of low grade.

III. A few of the prospects such as Hicks-Wise's Crumpton's, and Middlebrook's may prove to be comparatively free milling; and permanent development work may result in profitable operations.

IV. Deeper work is warranted on most of these prospects examined, because of the rich results obtained from many, from the outcroppings, and the fact that so far as work has progressed the ore has maintained its continuity in value.

V. The permanency, and extent of these ore bodies, can only be proven by deeper and more systematic prospecting; while the values can only be determined by thorough test and sampling, by the various treatments known to science.

Results of Assays by Dr. J. H. Pratt, of Birmingham.

2058 Lee Mine, Sec. 2, T. 17, R. 11 E. $12.61 gold per ton, no silver.
2068 Gold Ridge, Sec. 34, T. 17, R. 12 E. $4.82 gold per ton, no silver.
1966 Hicks-Wise, Sec. 2, T. 17, R. 10 E. $3.14 gold per ton, no silver.
1967 Hicks-Wise, Sec. 2, T. 17, R. 10 E. $4.30 gold per ton, no silver.

HILLABEE (IWANA) GREEN SCHIST BELT.

A belt of light green colored, highly pyritiferous, altered eruptive rock occurs paralleling the "Talladega" slate proper of the Talladega Mountains, on the south-eastern edge; and apparently maintaining its continuity along the line of strike, from the Coosa River, near the mouth of Weogufka Creek, towards the north-east into Cleburne county.

This rock is distinguishable from the "Talladega" slates by the large percentage of unaltered pyrites it carries, as well as by its massive structure, hardness and toughness. These last characteristics cause it to be very difficult to drill and blast; while the quantity of crystals of pyrites imbedded in it has proved in the past very attractive to prospectors for copper ore. At the present day it is receiving attention from the prospectors for iron pyrites for treatment in the acid plants, in converting such into sulphuric acid.

With what degree of success this class of mining will be attended in Alabama, is impossible to determine at this early date; because the industry has not passed beyond the age of infancy.

The Chulafinnee and Arbacoochee Mining Districts

in Cleburne county are located on the south-eastern border of this formation. As early as 1842 placer mining was carried on in these districts very extensively. Especially was this the case with regard to Arbacoochee, when the town bearing that name was a typical placer mining camp, in all that the name implies. The stories of big nuggets, and rich pockets or beds of gravel, are

to a certain extent facts, proven by the returns from the Mints, in which Alabama is credited with producing $365,300.00 in gold between the years 1799 and 1879, the bulk of which came from this district. I group these districts under one head because they are in the same geological formation, the continuity of which is maintained throughout. While Chulafinnee is located about 10 miles to the south-west of Arbacoochee, and across the Tallapoosa River, yet from a miner's standpoint the relationship between the two localities is so close that I am justified in classing them under one head; although I shall consider the occurrences of gold-bearing ore and gravel in each separately.

The Chulafinnee Mines are located, so far as at present discovered, in Secs. 14, 15, 16, 23, 24, 25, T. 17, R. 9. E. The most extensive placer mining in the past was done on these tracts, through which the waters of Chulafinnee and Carr Creeks flow.

Judging from the extent of the tailing dumps and workings, the gravel beds must have been quite extensive. But these have been worked out where profitable, and to-day some five or six feet of surface soil have to be removed to reach gold-bearing gravel, which will pay an average of 75 cents a day to the man by sluicing. Consequently these cannot any longer be considered as paying placer mines, though the formation would warrant investigation with the view of adopting hydraulic mining, and such might prove profitable because the gravel beds exposed under the soil are apparently of considerable extent.

So far as quartz mining is concerned, but little work has been performed, except at the

King Mine, Sec. 16, T. 17, R. 9 E.—Here a stamp mill was in operation in the "seventies;" but work was abandoned, it is claimed, because of litigation. The old

openings show that mining was carried on quite extensively; but it is impossible to form any estimate of the extent of the ore body, because the deeper shafts are filled with water, while the shallow openings have been abandoned so long they are filled with debris. In one pit, near the surface, I was enabled to expose a seam of hard white quartzite about six inches thick, having a N. and S. strike, and dipping nearly vertically towards the E., bedded in strata of decomposed schist. This, however, could hardly have been what the owners were working, because it only assayed $1.03 a ton in gold.

From the extent of this pit, the mouth of which covers an area of some 2,500 square feet, it would appear as though the country rock had been milled, as well as the thin strata of quartzite.

Striplin, Sec. 22, T. 17, R. 9 E.—Here sufficient prospecting has been done to show the occurrence of a body of gold-bearing quartz of irregular structure, characteristic of such outcrops as miners designate as "blow-outs or burst-ups."

The shallow openings were made on the summit of a ridge, extending N. E. and S. W. between the head waters of Carr Creek. The gravel in both of these branches is gold-bearing, and the old dumps and pits show that placer mining of extent was done in the past. Sufficient depth was not reached in this prospect work to determine any facts relative to extent, value or permanency.

On the south-east slope of this ridge another pit some eight or ten feet deep exposes some narrow stringers of a white sugary quartzite, with a north and south strike and almost vertical dip towards the east, bedded in strata of decomposed schist, apparently the same as occurs in the Arbacoochee mines. This prospected fairly well by panning without crushing, thus showing that the gold from the quartz had been disseminated through the

decomposed schist, to some extent.

The quartz in this prospect I preserved after panning, and by assay it yielded $3.31 in gold a ton.

Samples I took from several outcrops assayed between sixty and seventy cents a ton in gold.

A discovery has been recently reported (Sept., 1894) as having been made on the

Higginbottom Property, adjoining the Striplin on the north-east. The ore body resembles the thin strata of quartz and decomposed schist described as occurring on the Striplin land. It pans very richly at the surface, and is sufficiently promising as a prospect to warrant the performance of work, to prove its extent and value at depth.

Between the Chulafinnee mines and Arbacoochee mines no discoveries of gold have been made. In fact, I can learn of no prospecting work of recent date that has been done; although the formation maintains its continuity and gold can be panned out of the gravel in nearly any of the creek beds or gullies, in small quantities.

Arbacoochee Mines, Sections 5, 6 and 7, T. 17, R. 11 E. These sections, I learn from information, as well as observation, judging from the old dumps and workings, furnished all the gold credited to Arbacoochee in the old days of placer mining.

To-day there are spots on either of these sections which yield profitable results from sluicing, and a large area would pay for hydraulic mining, provided water could be obtained in sufficient quantity, and pressure by gravitation.

On section 5 hydraulic mining has been carried on at irregular intervals for several years past. But as no record of the yield has been kept, it is impossible to make any reliable estimate of the amount of gold cleaned

up. Traditions are related which, however, cannot be sufficiently reliable to base any statistics upon. Many of these place fabulous values on some pockets and beds of gravel washed out in the past. Nuggets ranging in value from $1.00 to $1,300.00 are claimed to have been found by different miners at various spots throughout the entire district.

There is one feature which deserves attention, and it is the fact that at no point has solid formation been reached in the old workings. The bed rock has been considered to be a red clay* which underlies the gravel beds. These gravel beds occur in pockets about three feet in thickness, and very close to the surface, on a ridge, which apparently was the bed of the creek, which has since cut its channel to a considerable depth below the summit of this ridge.

To determine the present value of these hill "diggings," as they may be termed, would require a vast amount of time and actual work, which the survey is not prepared to devote to it.

In 1893 an expert examination was made by W. M. Courtis, of Detroit, Mich., of a portion of *Sec. 6, known as the "Denson" property*. This expert informed me at that time that the value of the placer ground on a portion of the section was 20c. a yard. However, he gave me no figures as to extent, which, of course, would be most important. But as to water facilities, he informed me it would be necessary to bring the supply from the Tallapoosa River, the nearest point being about two and a half miles.

Considerable prospecting for quartz veins has been done in this district with varying results. But no plant has ever been erected to treat any of the gold-bearing

*This "red clay" is in many places seen to be merely the thoroughly decomposed rock, the "saprolite" of Prof. Becker. See also Report of Alabama Geological Survey for 1874, p. 44. E. A. S.

quartz, although several veins (usually thin) have been exposed in the prospect pits, which yield good results. Some very fine free gold specimens, the quartz carrying the gold being of a whitish sugary nature, have been found both as float and in some of the vein stone.

The maximum extent in width of the Arbacoochee gold-bearing gravel belt is attained on sections 5 and 6, where it is fully one mile across from the northwestern to the southeastern boundaries. One very noticeable difference occurs in the country rock on the north-western side of this belt and that on the south-eastern, or rather in the formation which parallels this "Iwana" rock formation on the north-west, and that which parallels the placer district on the south-east. The "Talladega" slate beyond the north-western boundary is less crystalline, and carries no "iron garnets" (i. e., altered pyrites) ; but apparently the same type of slate beyond the south-eastern body is very highly garnetiferous, and almost fully crystalline, graduating into hydro-mica and mica schists further to south-east. Another appreciable difference is that the formation to the north-west for a distance of at least five miles is, so far as at present known, entirely non-mineral bearing ; while on the south-east it is gold bearing.

In following the Arbacoochee belt towards the north-east and along the Trickem Valley, I found that less regularity existed in the maintenance of its width than is the case to the south-west. Although towards the south-west the pay diggings are found to occur only in spots, yet the formation maintains its continuity and average width yielding colors generally where any gravel is washed, beyond the recognised limits of the placer diggings ; but not sufficient to warrant its classification as pay dirt.

Hence, while the formation is continuous from Chulafinnee to Arbacoochee, it is only on the tracts I have par-

ticularly referred to that pay diggings really occurred.

Near and below water level quicksand occurs in this formation through the northerly portion of the district, but in the southerly hard bed rock is reached at shallow depth.

In a north-easterly direction from Sec. 5 the placer belt diminishes in width very rapidly, and near the north-west corner of Sec. 2, T. 17, R. 11 E., it is entirely lost, so far as the State of Alabama is concerned; at least, so far as is at present known from the prospecting that has been done.

During the summer of 1895, the Hilton Brothers and R. E. Merrill obtained an option on 200 acres of section 7, and the first named a lease on 20 acres of the Denson property on the west half of section 6, and immediately adjoining section 7 on the north side. This action was based on a tradition of a very rich find made by a man named Marable in the "forties," in the placer ground drained by Clear Creek. The father of the Hiltons had marked the location of this find, and bequeathed the knowledge to his family before his death. The understanding was, that at any time the brothers could obtain an option or lease on the property he designated, that they should work it for the benefit of the family. Tradition said that Marable had taken 11¾ lbs. of gold from this pit in a half day, celebrated his discovery by a carousal, during which he died. The pit in the meantime had filled with water, and had not been disturbed since that day in the "forties," until the summer of 1895.

After prospecting for some weeks the ore was encountered, together with a large quantity of gold dust and nuggets. The most important feature of this discovery was the auriferous quartz in place. A dispute arose between the owners of the properties relative to the land line as soon as the discovery was made, which caused

the suspension of operations at that particular point. When work was stopped, a fresh fracture in the quartz in place showed native gold imbedded in it, in sufficiently large particles to be visible to the naked eye 20 feet distant.

The country rock proved to be a gneiss,* in which the auriferous quartz was bedded, the strike and dip conforming, so far as seen, with the structure of the country rock. Sufficient work had not been done to determine the structure of this ore body, or its permanency. In thickness it was about six inches.

The result of this discovery was the performance of a large amount of prospecting work by a Chattanooga syndicate to which the Hiltons had sold their option. This was done at several points on section 7, and is being carried on at the time of making this report.

Other adjoining properties shared in the activity and the entire district changed its aspect from one of abandonment to one of life.

T. H. Aldrich of Birmingham optioned the east half of section 6, or the Creamer property, as it is locally called. He commenced a systematic method of prospecting to endeavor to discover the rich ore body to the north-east along its line of strike. Several cross cut trenches were dug, and at two points the ore body, or what was apparently the same, was cross cut. These were located about 1,000 and 1,700 feet, respectively, from the Marable. If these belong to the body discovered by the Hiltons, then there is every reason to believe that a series of faults occur in the formation which have thrust the body from its normal line of strike, because where discovered by Mr Aldrich, the auriferous quartz is 600 or 700 feet north of the normal line of strike. This theory is tenable from the fact that in a shaft sunk 30 feet south, of the Marable pit, a well defined fault is seen, and in a pit sunk a few degrees west of south of the Marable

*See Mr Brooks' notes, Part II of this report. E. A. S.

pit, a few feet distant, and on the line of strike of the ore body, such was not exposed. If the ore body was continuous, it must have been exposed in this pit.

The same country rock as is encountered in the Hiltons' workings is found to extend through the east half of section 6 to the north-east, as well as through section 7 to the south-west, and is apparently about 800 feet wide. This is a gneiss, and further examination proves that the same character of country rock is continuous through this as well as the Chulafinnee mining district on the opposite side of the Big Tallapoosa river, crossing that river in the vicinity of Denman's bridge. Several bodies of auriferous quartz, of low grade, at the outcrop, cross the east half of section 6, but have not been prospected beyond its lines.

The Anna Howe, Anna Howe Extension and Crutchfield ore bodies form the north-western boundary of the placer diggings, and undoubtedly have furnished a great deal of the gold found in those diggings.

Although the outcrops of neither the Anna Howe nor the Crutchfield can be traced above the surface to the south-west beyond the west line of section 5, with sufficient clearness to establish continuity along the line of strike, with any of the quartz bodies in the Chulafinnee district, yet from the similarity in the relations of the two, I am of opinion that the ore body at the King Mine in Sec. 16, T. 17, R. 9 E. is really an extension of the Anna Howe.

In Coosa county some 60 miles or further to the south-west, in the same formation, (Talladega slate, close to the Iwana or Hillabee schists) we find the old *Parson's Mine, Sec. 4, T. 23, R. 17 E.*, which was worked quite extensively 4 or 5 years since. Here we have a narrow quartz vein with lenticular structure bedded in the slate, having its strike N. E. and dip towards the S. E. at 45 deg. When I visited this mine, in company with Dr. Eugene A. Smith, during the summer of 1894, we found it impossible to determine any facts with regard to permanency, extent or value

of the ore body. The old pits and dumps, open cuts, and deep shafts denoted that the mining operations had been on quite an extensive scale; but not performed systematically, or apparently with any view to development for future mining. The idea being, as it seemed to me, to obtain what ore could be got as cheaply as possible, and let the workings fill up with water or cave in.

But to return to the *Anna Howe Extension, Sec. 34, T. 16, R. 11 E.* and *Crutchfield on the same section*, in fact a portion of the same property.

The ore of the last named has been discovered at no other points except on this property, and on Sec. 3, T. 17, R. 11 E.

The abandoned pits along the line of strike of this ore body on Sec. 34, are evidence of the work done in the past, when as I am informed some $2,500.00 was taken out of the vein, which varied from 4 in. to a foot thick, from shallow pits. These were sunk 10 or 15 feet on the dip of the ore body, which lies almost flat, dipping towards the south-east. All the ore that could be worked out, without timbering or danger from caving, was mined. That pit was then abandoned for another, to be in its turn worked out and abandoned, until the line of pits reaches for nearly half a mile in a course slightly north of east.

On Sec. 3, T. 17, R. 11 E. known as the Valdor property, a shaft about 10 feet deep has been sunk on an ore body, apparently an extension of the Crutchfield. An ore body or bedded vein, having lenticular structure, and varying in width from 4 inches to a foot has been exposed. This dips to the south, lying almost flat, and has its line of strike N. W. at this particular spot. But on Sec. 34, the vein has the normal line of strike general in the Alabama gold fields N. E. Except that the ore has the same appearance, and in general characteristics, except strike and direction of dip; these ore bodies bear strong resemblance, bnt I can not determine positively that the Valdor is

an extension. The fact that the line of strike of the slates changes on the *Anna Howe, Sec. 33, T. 16, R. 11 E.* makes a strong presumption for the theory in favor of the extension.

The Anna Howe itself was one of the first gold bearing quartz discoveries in the Arbacoochee district. It is a segregated or bedded vein of highly sulphuretted white quartz, plentifully stained with iron, and partially porous and decomposed. From the surface down, a distance of about 100 feet, on an incline with the dip of the vein, the country rock enclosing this ore body, had much the same appearance of decomposed schist and quicksand as is found in the placer diggings. But at that depth this gave place to the solid "*Iwana*" or *Hillabee* schist walls, highly pyritiferous, carrying crystals of unaltered pyrites, in quite large cubes, as well as forming a large per centage of the entire mass of slate. When this solid formation was reached, I am informed, that the vein pinched out entirely, and further work was abandoned.

That portion known as the Anna Howe was sold to a syndicate composed chiefly of New Orleans capitalists, who organized as the Anna Howe Gold Mining Company. A Huntington Mill complete, with Frue Vanner concentrating table attached, was erected, and treatment of the ore commenced and continued until, as I have already stated, work was abandoned when the ore pinched out. Since that time the mine has remained idle, and the workings and incline shaft are full of water. The prospectus of this company signed by George D. Stonestreet, Mining Engineer, and Member Am. Institute Mining Engineers, is certainly a work of art, so far as estimates with regard to extent and permanency of the ore body is concerned. He figuring on 190,728 tons of ore in veins, and 297,000 tons of placer gravel in sight approximately, as well as figuring on the yield of a profit of $6,646,857.00, or 40¾ per cent. per annum. As an actual matter of fact, it is absolutely impossible to

figure on any ore in sight, even under the most favorable circumstances. Because, as I am reliably informed and as the extension shows, the ore body has that irregular lenticular structure, on which it is very unsafe to form any estimates regarding the quantity of ore in sight, even when the mining is of such a character as will enable any estimates to be made. Besides this, the ore body at its thickest was only a narrow seam, as is shown on the extension. I call attention to these facts not to condemn any particular man or property; but because I consider it against the best interests of the state for such perverted and exagerated statements regarding the facts to be published and circulated.

About the same time that the Anna Howe was sold, and the company organized, a syndicate of Birmingham and New Orleans capitalists purchased the *Extension on Sec. 34, T. 16, R. 11 E.*, and organized another company. Active mining operations were carried on for a while, which were chiefly confined to the Crutchfield vein which I have described earlier in these pages. No plant was erected by this company and work was abandoned when the same course was pursued at the Anna Howe mine proper.

Recently work has been resumed on the extension, by a lessee; who pumped out an old shaft sunk in 1877 and continued sinking in order to cross cut the ore body at depth in the solid formation and prove the conditions there existing. After sinking for several feet, and attaining a depth of some 60 feet from the surface, the water became of greater volume than the capacity of the pump, and work on this was suspended. The only results demonstrated were the extreme hardness of the "Iwana" and rock, that the percentage of pyrites carried by that rock, did not increase to any marked extent as the sinking progressed.

The lessee then re-opened an old tunnel and incline

which had been abandoned when mining was discontinued. From this opening he succeeded in taking out about ten tons of a highly sulphuretted quartz, somewhat decomposed and porous in spots, as well as being plentifully stained with iron oxides. This he attempted to mill and treat by amalgamation, saving the concentrates with blankets. He informed me that he succeeded in saving $175.00 from the ten tons; besides the concentrates, of the value of which he was unaware. From the appearance of the ore, and all the general characteristics of the formation, this is certainly an extension of the Anna Howe vein. The ore body is only a few inches in thickness, and has the lenticular structure, and almost flat dip, typical of this district in the quartz veins.

On Section 5, T. 17, R. 11 E., an ore body resembling the Anna Howe vein has been exposed in a shallow prospect hole, but sufficient work to determine its extent had not been performed at the time of my visit. Some of the ore near the surface, after being thoroughly roasted and treated by stiff amalgamation, yielded about $30.00 a ton in gold. This ore though is not adapted for any treatment other than barrel chlorination or smelting, or possibly the cyanide process.

The line of strike of the Anna Howe vein is irregular, and by actually following the formation I found it assumed a zigzag course. Consequently it is found, especially towards the north-east from Sec. 34, to change from North-east to North-west several times within a few miles. Near the north-west corner of Section 2, T. 17, R. 11 E., it assumes its normal line of strike; but near there it is apparently cut off by a fault, and together with the placer belt is lost to the north-east so far as Alabama is concerned. From the geological conditions surrounding the locality, there is foundation for the theory that the Camille Mine in Haralson county, Georgia, is the north-east extension of the Anna Howe ore body.

Assays.

Assays by Dr. J. H. Pratt, of Birmingham, Ala., on samples from the Chulafinnee and Arbacoochee Districts, resulted as follows:

2049 King Mine, Sec. 16, T. 17, R. 9 E., $1.03 in gold per ton.
2051 Valdor, Sec. 3, T. 17, R. 11 E., Crutchfield vein, $5.17 a ton in gold.
2054 Striplin, Sec. 22, T. 17, R. 9 E., $3.31 a ton in gold.
2057 Anna Howe, Sec. 33, T. 16, R. 11 E., $12.40 a ton in gold.
1976 Reeves' Shaft, Sec. 6, T. 17, R. 11 E., $2.40 a ton in gold.
1977 " " Sec. 6, T. 17, R. 11 E., $2.36 a ton in gold.

TALLADEGA AND TERRAPIN MOUNTAINS.

Riddle's Mill. On Sec. 16, T. 19, R. 6 E., in Talladega county, near Waldo P. O. or Riddle's Mill, there is an occurrence of gold-bearing quartz. This is on the north-western flank of the Blue Ridge Range of Mountains, locally known as the Talladega.

The ore body is a white quartz, highly sulphuretted, and having its line of strike North-west, with its dip almost flat, and towards the S. E. The structure is that of a bedded vein, of lenses or kidneys of gold-bearing quartz; with its continuity maintained with depth, so far as mining has exposed to the depth reached, not to exceed 100 feet on an incline with the dip of the ore body. But in the connection found to exist between the lenses or kidneys, the thickness of the streak pinches to a mere trace; while these kidneys rarely exceed four inches at the thickest part. The value of this quartz varies from $20.00 a ton in gold to $150.00 by assay test. The country rock is the "Talladega" variety of semi-crystalline slate.

Some fabulously rich pockets, I am informed, were discovered at and near the outcrop. At one time a syndicate from Birmingham, Ala., mined and milled the ore for about 6 months; but work was abandoned because of the inability to save values by amalgamation.

A system of concentration was also adopted but proved unsatisfactory. Since then several local miners have from time to time leased the property, and sometimes made good wages with a pan, pestle and mortar, by crushing the surface ore, and panning it. During the summer of 1894, Mr. Walter Riddle one of the owners, milled the ore mined by lessees, in a small mill with light stamps, with some degree of success.

The continuity of this vein is maintained along the line of strike with well defined regularity, for a distance of some two miles to the south-west from the north line of Sec. 16. Mining of considerable extent but in a primitive method has been done on the Riddle property, and the prospect pits extend for over half a mile.

On the Woodward tract in Sec. 16 and adjoining the Riddle the same ore body has been prospected to a limited extent.

In a south-westerly direction from this last mentioned prospecting, the vein crosses Talladega creek, and can be followed by the float and outcrop of the country rock to the old

Story Mine, Sec. 17, T. 19, R. 6 E. where quite extensive mining operations and some milling were carried on several years since. The ore was mined from the surface down, on an incline with the dip some 60 feet. At the heading, and where exposed along the sides of this incline, the ore body shows the same characteristics as on the Riddle, and Woodward properties.

Towards the north-east I can learn of no successful prospecting in this formation having been done.

Some 3 miles to the north-east of Ironaton, a Mr. Seay the original owner of the Clifton Iron Company's ore lands, has prospected for years for silver. His prospecting work is founded on the traditions from the Indians, in which he apparently has implicit confidence; because although his work has invariably resulted in failure yet he persists in continuing his search.

Further to the north-east in the Terrapin Mountains and in the same "Talladega" semi-crystalline slate formation, but on the extreme north-western edge are occurrences of quartz. These, or rather some of these, I find by prospecting carry a little gold at the outcrop, but not sufficient to warrant, in my opinion any investment of capital, to develop. But no work of any extent has ever been done. The quartz seams bear a strong resemblance to those around Waldo,

and are impregnated with crystals of iron pyrites, sometimes measuring nearly an inch across the faces.

Graphitic slate.—There are indications of a deposit of graphite on *Sec. 2, T. 13, R. 11, on the Treadway plantation.* A short tunnel run into a bed of graphitic slate, highly pyritous, several years since has exposed such a deposit. It is possible that further work might result in exposing a deposit of solid pyrite.

Assays.

Assays by Dr. J. H. Pratt show the following results:
1993 Riddle's near Waldo, $35.97 a ton gold; 83 cts. silver.
1994 Woodward's $145.83 a ton gold; $1.58 silver.

MICA AND KAOLIN DEPOSITS—UPPER BELT.

There are, as far as my observations have reached, associated with Alabama gold belts, four distinct belts of granite veins carrying mica, and feldspar. Their commercial value, and importance, are to-day almost entirely speculative, because of the limited extent of the mining operations, as well as crudeness of the actual work done in the past, and shallow depth attained in the workings.

The feldspar is found, so far as present development shows, usually in a state of decomposition, or as kaolin. This result of decomposition has been promoted by the action of the carbonic acid of rain and other waters, which removes the alkali; also by that of the organic acids which the decomposition of plants or animals contribute to such waters.

While apparently several quite extensive beds of this kaolin exist at some points along the mica belts, yet at present the extent is unknown, because no systematic work calculated to determine such has been performed.

On the Denman property, Sec, 21, T. 17, R. 10 E., the indications are that a bed exists capable of producing a sufficient quantity of high grade kaolin, to warrant the erection of a plant for the manufacture of fine porcelain, in the vicinity of Heflin in Cleburne county, on the line of the Georgia Pacific Railroad 8 miles distant from the mines.

Several tests have been made of this kaolin as to grade; and ware has been manufactured from it. This, I am reliably informed, was pronounced equal to any ware manufactured from the imported China clay.

The only vicinity where feldspar, in crystals, sufficiently hard and pure to possess a commercial value, has been discovered, up to the present time, is in the neighborhood of

Hissop P. O. in Coosa county.—There a fine body of

considerable extent has been mined and some sample shipments, made to the Standard Coal and Coke Company of Brookwood, Ala. Such has been successfully used in the coal washers for bedding by that company, and will probably lead to the establishment of a new industry in the State, *i. e.* prospecting and mining feldspar.

The mica bearing belts are apparently south-western extensions of those of North Carolina and Georgia. Although their continuity can not be traced from the north-east by the surface indications, yet we find from the geological formations, and geographical locations that this theory is tenable and warranted.

The most northerly location of any mica of commercial value occurs on

Sections 23 and 21, T. 17, R. 11 E.—While the surface indications are very encouraging on these properties, yet but little work has been done in developing the discoveries, and no estimate as to permanency or value can be made.

To the south-east from these sections, and near the northern boundary line of Randolph county, occurs what I consider the mother ledge, so far as Mica and Kaolin are concerned.

This belt attains its maximum width in *Randolph county, in the vicinity of Pinetucky Gold Mines.* In this vicinity the width is about five miles; but to the north-east and south-west, while the continuity of the granite veins is maintained an undetermined distance, the width of the belt, so far as at present known, is much less.

Surface indications of mica deposits, of commercial value, occur along the lines of strike of the Pinetucky granite veins both to the north-east and south-west, at several points. Especially so is this the case in Clay county. But in no other portion of the crystalline region of the state have I found deposits, where the prospects

for obtaining mica of a commercial value, cover such an extensive superficial area as do these.

The most extensive mining operations have been carried on at the properties of *Miller, Sec. 1; Phillips, Sec. 1; and Merrill, Sec. 12, T. 18, R. 10 E.*

From all of these properties mica has been mined and shipped for use in stoves and furnaces. Samples have also been sent to the leading electrical companies for test as to quality for their use. Such have been pronounced by experts as being thoroughly well adapted for use for electrical purposes.

Good surface indications and outcrop occur on the *Ayres and Linville properties in Sec. 19, T. 18, R. 11 E.; also on the Messer land, Sec. 18, T. 18, R. 11 E.; White's, Sec. 6, T. 18, R. 11 E.; Crews' Sec. 30, T. 18, R. 11 E.; Lander's Sec. 22, T. 18, R. 10 E.; and on several other tracts of land in this same neighborhood, owned by the Birmingham Banking and Trust Company of Birmingham, Ala.* These last mentioned tracts form a portion of some 30,000 acres purchased a few years since by Dr. Caldwell and associates, when it was expected that a railroad would be built through this portion of Randolph county.

Shallow prospecting pits have been sunk at several locations on all these tracts; but the only deposit which has been sunk on below water level is on the Merrill property, adjoining the *Pinetucky Gold Mining property*. There water came in and interfered with the sinking of a shaft at 55 feet below the surface. Below this point the size of the mica crystals, and grade of the sheets after the crystals were split, were superior in a marked degree to that taken from nearer the surface.

No mining calculated to show the extent or permanency of the veins in which the mica is found has been done at any of the prospects. The only object apparently in view when work was in progress, being to take out all the mica in sight without any regard to future devel-

opment of the properties. Consequently the result has been such as renders it absolutely impossible to estimate with any degree of reliability the extent, permanency or value from material in sight. There are in all probably 30 veins which carry mica in crystals of sufficient size to warrant being prospected, occurring on the strip of which I have given the width as five miles. Many have not been prospected at all, and all of which have been prospected only carry mica in paying quantities in spots. Actual shipments have only been made from a very few mines, and such only in limited quantities.

To the south-west and across the Tallapoosa River on this belt there has been very little work done prospecting for mica, feldspar or kaolin. The surface indications at some points near the village of Delta show that good mica may possibly be fouud if prospected for.

About five miles north-west of Lineville the outcroppings show good indications of the occurrence of mica, but samples I have seen from the vicinity show too much iron stain to render the mica adaptable for electrical uses, and the work is too shallow to assist in determining its quality at depth. Some little work has also been done on Lundy Mountain, near Chandler's Springs, and fairly good mica obtained.

The third belt occurs on the extreme south-eastern border of the Mica-schist gold belt. In and around *Rockdale, in Randolph county*, considerable prospecting work has been done, but the work has been abandoned some years since, and I can obtain very little information regarding the results. The properties on which this work was done form a portion of the land owned by the Birmingham Banking and Trust Company, to which I have before referred.

The fourth belt of mica deposits occurs paralleling the south-eastern edge of the Silver Hill Gold Belt, in Tallapoosa county. To this occurrence of mica I have already

referred in my report on the Silver Hill belt. It is impossible to obtain reliable statistics as to the quantity of mica which has been mined in Alabama up to the present time; but the extent of the work done at the mines is so limited that the output must necessarily be also limited.

There are many pre-historic pits of considerable depth and extent found in the vicinity of some of the mica deposits, where trees of large dimensions have grown on the old dumps, and in the bottoms of the pits. But when such work was done, or whether the incentive for the work was mining for mica or feldspar, cannot be ascertained to-day

PART II.

SUPPLEMENTARY NOTES ON THE MOST IMPORTANT VARIETIES OF THE

METAMORPHIC OR CRYSTALLINE ROCKS

OF ALABAMA;

THEIR COMPOSITION, DISTRIBUTION, STRUCTURE, AND MICROSCOPIC CHARACTERS.

A. A GENERAL ACCOUNT OF THE CHARACTER, DISTRIBUTION, AND STRUCTURE OF THE CRYSTALLINE ROCKS OF ALABAMA, AND OF THE MODE OF OCCURRENCE OF THE GOLD ORES.

BY

EUGENE A. SMITH.

The gold region of Alabama occupies a triangular area in the eastern part of the state, bounded by a line entering the state from Georgia five or six miles south of the parallel of 34 deg., running thence south-westward to Jemison, in Chilton county, and from that point through Wetumpka to Columbus, Ga. In this area are included parts or all of the following counties: Cleburne, Clay, Talladega, Coosa, Chilton, Elmore, Tallapoosa, Macon, Lee, Chambers and Randolph, aggregating about 4,425 square miles in area. It is the termination towards the southwest of what has been termed by Prof. G. F. Becker, of the U. S. Geological Survey,* the Georgia belt of the Southern Appalachian Gold Fields.

The Rocks.

These are practically all *metamorphic* rocks which, considered from the point of view of their origin, fall into two classes, viz., those derived from sedimentary or fragmental rocks, and those derived from igneous rocks. Until recently, all metamorphic rocks were considered as belonging to the first of these classes, the planes of schistosity passing for the bedding planes of the original

*Reconnoissance of the Gold Fields of the Southern Appallachians, in the 16th Annual Report of the Director of the U. S. G. Survey.

sediments, but modern petrographers have shown that through the agency of crust movements accompanying the upheaval of mountains, etc., the massive igneous rocks may be crushed and sheared in such a manner as to produce in them planes of easy cleavage or schistosity, in appearance similar to the bedding planes of the altered sedimentary rocks. By the same agency, planes of cleavage or schistosity may be developed in the sedimentary rocks also, and these secondary cleavage planes may or may not coincide with the original bedding planes. By the study of thin sections of rocks by means of the microscope, it is possible in many cases to determine whether or not a given specimen is made up of water-worn or rounded fragments, i. e., whether or not it is of sedimentary origin.

In other cases it may be impossible to determine even this much without closely examining a large number of hand specimens, or better still, extended observations in the field. It must be understood, therefore, that the assignment here given of our metamorphic rocks to one or the other of the classes named, is not by any means to be considered as final, since they have as yet been comparatively little investigated in the light of modern methods.

Similarly as regards the age of these crystalline rocks, they cannot be brought into a single class, for the Talladega slates, being sedimentary, must rest upon still older rocks, whose debris has furnished the material out of which they have been built up, and in the gneisses and some of the hornblendic schists we probably have the representatives of this older class. Again, the diorites, granites, and other intrusive rocks which fill the fissures in this older set, are of course more recent than the rocks which they traverse. The Talladega slates, in their turn, in places apparently enclose masses of intrusive granite, which by consequence would be

younger than they are. So, taking the great country-forming series, the gneisses and the Talladega slates, we have the representatives of at least two distinct eras, and in the intrusive rocks possibly a third, although part of these may be contemporaneous with the Talladega series.

In the present state of our knowledge, the older gneisses must be classed with the *Archæan*, while the Talladega slates will probably be assigned to what the Geologists of the U. S. Survey have named the *Algonkian*. One can, however, hardly avoid the suspicion that some of these semi-crystalline slates are no older than the Cambrian, although as yet the fossils have not been found to prove it.

The bulk of the eruptive rocks also will probably have to be assigned to the Algonkian.

1. ALTERED SEDIMENTARY ROCKS.

Ocoee, or Talladega Slates and Conglomerate.

Distribution.—As regards their surface distribution, the Ocoee or Talladega rocks are found in four or five roughly parallel belts, running with the general structure of the country, i. e., north-east and south-west. The main belt is that which lies furthest to the north-west, and borders the Cambrian and Silurian strata of the Coosa Valley. This belt has a width of five to ten miles according to locality, and it appears as a range of mountains with some of the highest elevations in the state. The names Blue Mountain, Talladega Mountain, Rebecca Mountain, etc., are applied to this range in different parts of its course, Talladega Mountain being the most generally applicable name. This range entends through Cleburne, Talladega, Clay and Coosa, into Chilton county where it passes gradually below the sands and clays of the Tuscaloosa formation of the Cretaceous.

The other areas of Talladega slates are found as narrow strips in the midst of the gneisses, much as though they had been accumulated in troughs of these rocks, yet other, and possibly more probable, explanations of their present attitude may be given. Two of these interior belts, as they may be termed, are wider and more persistent than the others, and of these, the one lying nearest to the main mountain belt, i. e., furthest northwest, is the more important. This belt extends through Coosa, Tallapoosa, Randolph and the lower part of Clay. It widens and ramifies towards the northeast in Randolph county, and it may be called the Goldville belt, since it includes Goldville, Hog Mountain and other localities formerly much worked for gold.

The next belt may be followed from near Eclectic, in Elmore county, north-eastward through Tallapoosa into Randolph, and through it to the Georgia line; but in the eastern part of Randolph its limits are not so clearly defined as they are in the rest of its course. In this belt occurs the Silver Hill gold mining region which was formerly much worked, and we name it accordingly.

There are in addition to these, two minor belts of altered sedimentary rocks, viz., one in Coosa county running north-eastward nearly through Rockford and merging into the main mountain belt beyond Goodwater; and one in Lee county, extending from Farrall's Mill by Wright's Mill to Chewacla and Springvilla lime works, beyond which it has not as yet been certainly identified. This will be mentioned again in connection with its most characteristic rocks, the crystalline dolomite.

Rocks of the Talladega Series.—The most abundant of the rocks of this series is a smooth, nacreous, *clay slate*, or *argillite*, of brownish gray, to greenish colors, feebly crystalline, and in places very closely resembling some of the variegated shales of the Montevallo series of the

Cambrian formation, and there are localities near the contact of the Cambrian with the Talladega, where the Cambrian shales, being slightly altered, are almost identical in appearance with some of the Talladega slates. Such partly altered shales of undoubted Cambrian age may be seen along the line of the L. & N. R. R. below South Calera, and in the vicinity of Clear Creek and Jemison; in the Kahatchee Hills in Talladega county; and further north-east in Calhoun county near Davisville; and in Cleburne in many places near the line of contact. In the north-western belt of the Talladega slates there is another series of more highly siliceous rocks, viz., *quartzites* and *quartzitic conglomerates*, constituting a very considerable part of the mountain ranges, interstratified with the greenish and grayish slates, and well exposed where Talladega Creek makes its way through the Talladega mountain, as well as in all the gaps and along the summits of these mountains. These strata, like the others, have generally a decided dip to the south-east, but along the summits they appear to be nearly horizontal, making occasionally broad flats which support a fine growth of grasses, and are admirable grazing places for sheep. One instance of this flat summit is in the mountain which ends to the south-east in the Pulpit Rock, on the border of Clay and Calhoun.

The quartzites and conglomerates like the slates above mentioned, resemble very strongly some of the strata of undoubted Cambrian age, and it is impossible to resist the conclusion that some of the strata which we have included among the Talladega slates are nothing more than altered Cambrian shales, sandstones, and conglomerates. As yet, however, it has not been possible to discover any fossils in these altered rocks.

In the Kahatchee Hills, and the other localities above named, the sandstones and conglomerates of the Weisner horizon are in appearance almost identical with some of

the conglomerates and quartzites of the Talladega series.

In the other areas of Talladega slates lying further to the south-east, the strata are sometimes more decidedly altered than in the first belt, and are often much more decayed, holding numerous crystals of garnet and tourmaline.

In the *Turkey Heaven Mountain* region in Cleburne, we find a very well defined variety of these semi-crystalline schists consisting in the main of quartz but containing a large percentage of graphite and magnetite. These schists are of a dark slate blue color, with glistening surface, sometimes smooth and rubbing off on the fingers, sometimes hard and sandy. Through the dark blue black mass of the slates pass thin sheets of white quartz, giving the appearance of some of the banded diorites.*

Slates of this formation *impregnated with graphite* are common in many localities. Thus between Millerville and Elias, in Clay county, the soft slates are so highly impregnated with graphite as permit them to be used, in one locality near Millerville, for lubricating purposes. This belt is continued on towards Goodwater, where it is seen at several points in the railroad cuts. To the south-westward the same belt may be followed entirely through Coosa county, and another similar belt parallel with this passes through part of Coosa a short distance north of Rockford.

In the Silver Hill region graphitic slates appear in great force, suggesting by their color the name of one of the gold mines, Blue Hill. The graphite here opposes a very serious obstacle to the profitable working of the gold.

Another well defined variety in the rocks of this form-

*Mr. Brooks has described one of the rocks of this kind, No. 2 of his article.

ation is formed by the *highly fissile blue black slates* resembling roofing slates, which are generally met with along the eastern flank of the Talladega mountain range, a well known occurrence being near Chandlers springs.

Limestones, or rather *dolomites*, have been observed in two positions only in these areas, viz: (1.) On the south-eastern flank of the main slate belt of the Talladega Mountain at two localities, viz., (a) near Elder P. O. in the northern part of Clay county, where it is associated with the smooth greenish and gray slates above mentioned, and (b) in Chilton county in the river bluff not far from the mouth of Yellow Leaf creek. In these localities the dolomite is not much altered, but in the other belt (2), in Lee county, the dolomite is in part fully crystalline, white, and like the finest statuary marble, in part however, bluish and gray and less crystalline. These dolomites are closely associated with quartzites.

Near Wright's Mill, four miles from Auburn in Lee county, is the southernmost outcrop of these dolomites, formerly extensively worked for lime burning at the old Echols and Reese quarries. The dolomites occupy a narrow valley about a quarter of a mile broad, with a ridge of slaty quartzites to the northwest, and with *augen-gneiss* both to north-west and south-east.

At this place the rock is gray to blue in color, varying in composition from an almost pure dolomite to a rock containing a good deal of siliceous and micaceous matters. Some miles to the north-east of Wright's Mill is the Lime Kiln of the Chewacla Lime Company, where the dolomite is taken from a large open pit or quarry. Here there is a very large proportion of the white fully crystalline rock, along with some that shows bluish and grayish colors, and is very slightly crystalline. The quarry is in an open field in which there are few, if any, outcrops of the country rock, and so it is impossible to give much information concerning the associations, al-

though, judging by what may be seen further towards the north-east at Springvilla and the new quarries, the same associations prevail as at Wright's Mill, viz., itacolumites or slaty quartzites immediately adjacent to the dolomite, and *augen-gneiss* both to the north-west and to the south-west of the lime belt. Some details concerning the *augen-gneiss* will be found below in connection with what is said about the next series of rocks of this area.

Structure and attitude of the Talladega slates.—As a rule these beds have a dip to the south-east, the exceptions to this being very few.

In some parts of the Talladega Mountain range we find at the summit of the highest ridges, broad areas of nearly horizontal beds of quartzite and conglomerate, and in general the strata of these summits are much less inclined from the horizontal than they are on either flank, and it becomes thus at times impossible to resist the conclusion that some of these ridges are anticlinal arches overturned towards the north-west, the flat rocks at the tops being the crowns of the arches. In the ridge of which the Pulpit Rock is a part, this structure is perhaps better shown than elsewhere. In the interior belts the dip is almost invariably to the south-east. Prof. Tuomey speaks of the dolomite at the Chewacla quarry being nearly horizontal in bedding, but I have been unable to convince myself of this, as the rock is traversed by several joint planes making it very difficult to identify the true bedding plane. And wherever the quartzites with which the dolomite is associated are clearly exposed as at Wright's Mill, and the New Quarry near Springvilla, they are seen to stand nearly vertical, and it is probable that the dolomites also partake of this attitude.

2. ALTERED ROCKS OF IGNEOUS AND UNDETERMINED ORIGIN.

These, in the order of their relative abundance, include

the gneisses and the mica schists, to which are subordinated the granites, diorites and various hornblendic, pyroxenic and chrystolitic rocks occurring as dikes, together with the alteration products of the same, soapstone, talco, serpentine, etc.

These rocks represent more than one geological period, for those which occur as intrusions in the others, must necessarily be younger than the rocks which they traverse. We are not, however, yet in position to make definite classification as to age of these fully crystalline rocks, except in a few cases; we shall therefore limit ourselves to general statements concerning them.

1. The Gneisses.—These in structure vary from nearly massive granitoid rocks to fine grained mica schists. In most cases which have come under my observation, the granite "flat rocks" show traces of cleavage planes nearly perpendicular. Along the borders of these granite-like masses, the schistosity increases and the granite grades into gneiss. The grading of gneiss into mica schist is generally effected as shown below through a series of alternations of the two rocks, each maintaining its own character. The cleavage planes of the gneisses and other schists coincide generally with the structure of the Appalachian region in this state, the strike being in general about north-east and south-west, with slight variations. The dip also is in the majority of cases to the south-east; but there are exceptions, as will be seen below. Thus north-west of the Silver Hill slate belt, as above described, the dip of the strata is almost invariably to the south-east, while to the south-eastward of this belt the variations are more numerous. A *synclinal axis* may be followed easily and almost continuously from the vicinity of Tallassee, in Elmore county, past Walnut Hill in Tallapoosa county, crossing the railroad between Dadeville and Camp Hill; thence north-eastward, leaving Dudleyville to the west; past Thurman, crossing the

railroad a little south of Welch station, and then on towards the Georgia line. An *anticline* may be traced approximately parallel with the line of the Western Railroad from Farrall's Mill, in S. 30, T. 18, R. 25, E., past Wright's Mill, Chewacla Lime Works, Springvalla and thence through S. 7, T. 20, R. 28, E., to the river near the upper factory below West Point. Hornblendic rocks prevail to the north-west and mica schists to the south-east of this anticlinal, and at many points the gradual passage from hornblendic gneisses to mica schists may be perceived. This gradation is usually effected by alternations of the hornblendic rocks with the mica schists in a narrow belt between the two well defined types, and may be observed in sections 6 and 7 of T. 20, R. 28 east, and also near the upper factory above mentioned. Along the river road between West Point and Columbus, another *synclinal* may be observed, a little south of Osanippa (Berlin), and an *anticlinal* between Mechanicsville and Wacoochee, or rather at the latter place. These have not been accurately located further to the west for the reason that the superficial sands, pebbles and other materials of the Lafayette formation cover all the country in that direction, practically limiting obtervations of the underlying crystalline rocks to the drainage valleys, and to a very small part of them.

While the gneisses vary in structure from the granite-like masses to the highly fissile mica schists, they vary on the other hand in composition by the accession of hornblende, through hornblendic gneisses, often with difficulty to be distinguished from diorites, to hornblende schists. It is certain that variations also occur in the prevalence in different areas, of different kinds of mica and different kinds of feldspar, but we have had as yet too little of accurate study of these rocks to put us in position to speak very definitely on these points, except where we have had the microscopic examinations made,

which are given in detail in another part of this report. Within the area of the hornblendic gneisses occur in places massive diorites, resembling granite in structure, and like them of intrusive origin. Under the next head are given some details of the occurrences of these diorites.

In surface distribution, the gneisses, including the hornblendic gneisses with which they so often alternate, occupy (1) a belt lying to the north-west of the Goldville belt of Talladega slates. This we may call the Alexander City gneiss belt, which is practically continuous from the Coosa River nearly to the Georgia line. It holds many areas of "flat rocks" or granites in Coosa county, but in Clay and Randolph counties these granites are generally in the form of isolated masses in the Talladega slates, usually, however, close to the borders of the gneisses.* Towards the north-west the gneiss of this belt passes into a mica schist which very often continues up to the great mountain-forming belt of the Talladega slates, though this is not invariably the case, as for instance near Arbacoochee, in Cleburne county, where the gneiss lies next to the Talladega slates, or with only a narrow belt of the Hillabee or Millerville green schists between. This gneiss belt does not appear to reach to the Georgia line; or if it does, it is in much diminished volume, for beyond Arbacoochee, Hightower, etc., in Cleburne county, the Talladega slates are seen in direct north-eastward continuation of the gneisses.

In this first or Alexander City gneiss belt, there are many occurrences of coarse pegmatitic granite in dikes or veins. These veins are the sources of mica and of kaolin, and are most numerous and promising perhaps in the vicinity of Micaville, Pinetucky and Milner, in Randolph county; but at many points in Cleburne, Clay, Coosa and Chilton, along this belt, the mica has been

*Some of these "granites" are merely massive forms of the gneiss, but in other cases they occur as "dikes."

found in sheets of merchantable size, but in few, if any, of the localities of its occurrence has it been opened up to sufficient depth to be beyond the influence of the weather. Mr. Brewer has given localities and some details concerning these occurrences, and other details will be found in my report for 1874. In Randolph and also in Clay and Chilton, there are old pits where this mica has been worked in ancient times, for in these pits are now growing pine trees a foot or more in diameter. Near Hissop, in Coosa county, and at several points towards the south-west as far as Speed, this pegmatite carries beryls of quality suitable for cutting.

(*2*) The second gneiss-mica schist belt separates the Goldville and Silver Hill slate belts. In Coosa and Tallapoosa counties this belt is tolerably uniform in quality and width, but in Randolph it seems to divide, with Talladega slates between the division, and to break up into somewhat isolated areas in the midst of the Talladega slates. Three of these detached areas may be named, each containing some granite, i. e., one about Gay P. O., another just south and south-west of Wedowee, and a third a little to the north and north-east of Wedowee, the three areas somewhat *en echelon*.

(*3*) The third gneiss belt includes, with the exception of the dolomite belt, Chewacla-Springvilla, above defined, the rest of our crystalline region towards the south-east. In this third belt there are the ordinary gneisses and granites, especially near the north-west border of the belt, but hornblendic gneisses and diorites prevail and give character to the topography, soils, etc. In this last section, so far as I am aware, there are no occurrences of gold, at least in notable quantity.

To the south-west of the Montgomery-West Point Railroad, much of the gneiss assumes the character of *augen-gneiss*, in which certain of the constituents, generally quartz or feldspar, appear in "augen" or "eyes,"

i. e., somewhat elliptical shaped masses from one inch in diameter down. Several descriptions are given of this rock, as well as of the more common varieties, in the notes of Dr. Clements and Mr. Brooks below.

(*2.*) *The Diorites.*—After the gneisses and associated rocks, probably the most widely distributed of the rocks of this region are the diorites, which, as above stated, are often very difficult to distinguish from some of the hornblendic gneisses. The diorites occur as intrusive masses, often occupying long narrow strips in the direction of the strike, but sometimes as rather isolated masses of limited extent in the midst of the gneisses.

A belt of diorite (with hornblende schist in places) may be traced practically without interruption from near Verbena in Chilton county, through Coosa county past Hanover, Mount Olive and Pine Grove into Clay.

Somewhat in continuation of this line, but occurring more in detached masses we find this rock again in the lower part of Clay, while from about Chandler's Springs through Fishhead Valley, past Riddle's Bridge and thence north-eastward towards Wood's Copper Mine in Cleburne, there is another rather continuous outcrop like that of Coosa county.

To the south-eastward of the Silver Hill slate belt, hornblendic rocks are more generally present than in any other part of this section. Many of these are diorites, but the accurate mapping of these has not yet been attempted. The notes of Dr. Clements and Mr. Brooks describe a number of typical diorites from this area.

(*3.*) *The Hillabee, Iwana, or Millerville Green Schists.*—Along the south-eastern border of the main mountain belt of Talladega slates, there is an almost continuous outcrop of a green schists which microscopic examination discovers to be probably an altered eruptive rock. In the report of Mr. Brewer, which precedes, this is

spoken of as the Millerville, Iwana, or Hillabee schist, using the names of localities where it shows in typical form. It may be followed practically without interruption, but with somewhat varying width of outcrop, from Chilton county through Coosa, where it underlies a tolerably wide expanse of country about Stewartsville and Iwana; thence through Clay, about Hollins, Pine Grove, Mountain Meadow, Brownsville, Millerville or Hillabee, Coleta, Chandler's Springs, Fishhead Valley; and on through Cleburne, by Chulafinnee, Arbacoochee, Anna Howe, etc. Beyond Chulafinnee the outcrop narrows down to a small strip. It is widest in Clay and Coosa where it underlies a sort of Flatwoods, as is the case near Chandler's Springs, Coleta, and Hollins, in Clay, and between Iwana and Stewartsville, in Coosa. In fresh condition these rocks are of light green color and are rather massive in structure, and very tough, but on weathering they turn into greenish yellow slates much stained with iron, and then bear a striking resemblance to some of the Talladega slates with which they are in immediate contact. The soil derived from the weathering of these schists is a yellowish or reddish clay with a notable proportion of lime, indicated by the character of the growth which contains a considerable admixture of haw, crab apple and similar lime-loving plants. The manner in which the soil compacts under the wheels of vehicles is also suggestive of lime. When partially decayed, these slates as above stated, have a strong resemblance to sedimentary rocks, and especially to some of the feebly crystalline slates of the Talladega series. This resemblance is particularly strong in the case of some of the more siliceous varieties which imitate very closely some of the conglomerates and siliceous slates of the Talladega. In some of their outcrops they resemble impure slaty limestone, as is the case just below Coleta, in Clay county. In other places of their occurrence they

break up into long, slender and somewhat cylindrical fragments, exceedingly tough and resistant to weathering. The immediate vicinity of Chandler's Springs furnishes an illustration of this phase. The highly schistose and slaty varieties may be seen about Hillabee or Millerville, in Clay county, and particularly at Monroe's Mill close by. The varieties resembling siliceous conglomerate abound along the road leading from Millerville towards Hatchet Creek postoffice, and especially along the flanks of McGhee Mountain. In many places, and particularly where these rocks make a moderately wide belt of country, they form "Flatwoods," with decidedly calcareous soil, supporting a growth of short leaf pine and black jack oaks, with many haws, persimmons, poplars, crab apples and sweet gums interspersed. Such Flatwoods may be seen about Chandler's Springs and between the Springs and Coleta, also for a long distance along the road from Millerville westward towards Hatchet Creek, by Pine Grove and Hollins, and in great force near Iwana postoffice and on to Stewartsville. Below Stewartsville these flatwoods are succeeded by flat, long-leaf pine lands bearing some of the finest timber to be seen in middle Alabama. The siliceous rocks of the Talladega slate formation underlie a great part if not all of these pine lands.

In places the Hillabee schists hold a large percentage of pyrite in crystals disseminated through a siliceous rock. When the proportion of pyrite crystals is large it seems probable that the mineral might be concentrated without too much expense, so as to make it profitable to mine. In most of the cases which I have observed, the rock has a large percentage of quartz grains along with the pyrite. Attempts have been made at several points to mine this pyrite, especially in the vicinity of Hatchet Creek P. O. in Clay county, where it is relatively abundant. A large quantity of it was thrown out of the old

McGhee copper mine many years ago. At C. C. Duke's in S. 17, T, 23, R. 17 in Coosa county, some work has been done towards exposing the vein or seam which bears the pyrite.

Also in section 24, T. 19, R. 7 E., in Clay county, and at the old Montgomery Copper Mine close by, there is a very good show of pyrite. In S. 24 the seam is four to five feet in thickness, while at the Copper Mine it may be greater, for about the mouth of the old shaft there are masses of the pyrite of considerable size. It was impossible for me to see there any exposure of the vein or seam because of the falling in of the old works. In these cases, as in the lower part of Clay and in Coosa, the pyrites is mixed with quartz grains.

Microscopic examination of thin sections of these rocks shows that they are composed of actinolite, epidote, chlorite and zoisite in the main, with some quartz, and they have been named by Dr. Clements and Mr. Brooks Chlorite-epidote schists, Actinolite-epidote schists, Chlorite schists, etc., according to the prevailing ingredient.* In general, the alteration has gone on to such a degree that the determination of the original rock from which they have been derived is difficult, but all agree in thinking that they are result of alteration of some basic eruptive rock. For the present, therefore, we have grouped them together under the name *Hillabee*, from the locality where they are exposed in typical fashion. Some of the gold occurrences in the north-western belt seem to be closely connected with these rocks, as at Chulafinnee, Anna Howe, etc.

(*4.*) *Other Basic Rocks.*—At many points within the gneiss belt occur dikes and isolated masses of pyroxenic, chrysolitic and other basic rocks. These are mostly so much altered at the surface as to make it often very dif-

*See Nos. 38, 39, 40, 4 of Dr. Clements, and Nos. 4, 5, 6 and probably 9 of Mr. Brooks.

ficult to determine what was the original rock, for at the outcrop they appear in the form of chlorite, steatite, serpentine, etc. These occurrences have not been mapped as yet, and I shall call attention only to some of the best known. The notes of Dr. Clements and Mr. Brooks give many interesting details concerning them. In the great gneiss belt lying furthest to the north-west occurrences of these rocks are to be seen at several points; to the north of Goodwater; in a number of places near Flatrock post office, and in Fishhead Valley in Clay. In the next gneiss belt, these rocks occur at several places near the north-western border of the gneiss, e. g., at Robert Goodman's in S. 36, T. 22, R. 2, at Fosheeton and one or two points further north-east in the same line. Then along the north-western border of the Dadeville gneiss belt near its contact with the Silver Hill gold belt, e. g., in R. R. cut just below Dadeville; on Sandy Creek south of Dadeville; seven miles north of Dadeville, and thence in a north-easterly direction by Easton P. O. near Dudleyville; on towards Bosworth, near Slay's Mill in Chambers county. This seems to be a rather connected line of these rocks. At two places there is associated with these rocks along with steatite, chlorite, asbestos, etc., a notable quantity of corundum, occurring in detached masses. These two localities are Robert Goodman's, below Alexander City, and the vicinity of Dudleyville.

Near the Tallapoosa river, a few miles above Tallassee, there is a considerable mass of steatite which has been used by the Indian in the manufacture of pots and vessels of different sorts, the remains or fragments of which are abundant in the vicinity. Another similar locality is in section 35 or 26 of T. 20, R. 23, which may indeed be only another appearance of the same mass of rock. Here are also many fragments of the vessels formed from the soapstone. Of other soapstone localities I may men-

tion the vicinity of Oak Bowery, and S. 8, T. 21, R. 28 in Chambers. In a number of places, in Chambers county particularly, there is a variety of actinolite rock, often containing a good deal of steatite, and this is very generally known as soapstone. It has been quarried at a number of points and used for slabs over graves, for lining the Chewacla lime kilns, etc. One such locality is near Oak Bowery, on the place of Mr. W. P. Spradling, S. 34, T. 21, R. 26. Another is west of Milltown, formerly worked by Mr. Jackson, another at Five Points, worked now by Mr. Jackson's son.

In the upper north-western part of the Crystalline Schists the occurrences of dikes of the basic rocks are not so numerous, though not wanting, as has been shown above. Soapstone has been observed near Idaho Post-office, and at the Old Wood's Copper Mine in Cleburne; and at some other localities, and chlorite schists may be seen near Copper Mine P. O. in Clay, and in Fishhead Valley. The Hillabee Schists are generally considered as having been derived from some form or forms of basic igneous rock, not now determinable because of the alterations which they have undergone.

Mode of Occurrence of the Gold.

From Mr. Brewer's report and from that of Dr. Phillips, it will be seen that a large proportion of the gold-bearing quartz veins are associated with the semi-crystalline slates of the Talladega series, which are of sedimentary origin. These slates have in the past usually been referred to as talcose slates, and hydromica slates. Perhaps the term *talcoid* might be used with propriety, since they have the general look of talcose slates with, however, very little if any magnesia in their compositon. The gold of the Silver Hill belt, of the Goldville, Hog Mountain belt, of the Turkey Heaven Mountains, and of the Talladega Mountain belt occurs in slates of this kind. In many instances intrusive masses of granite or

of diorite appear in close proximity to the gold bearing slates. As an instance of this the Crooked Creek, Goldberg region, may be cited.

A second mode of occurrence of the gold is in association with gneiss, hornblendic gneiss, and diorites, as illustrated in the belt including Pinetucky, Franklin Mines, etc. A third association is with the green schists of the Hillabee type, as at Arbacoochee, Anna Howe, etc. At Arbacoochee, the gold occurs at the junction of these green schists with gneiss, so that the association might be considered with either.

The gold bearing quartz veins are in the great majority of cases what have usually been termed bedded veins or veins of segregation. They are so termed in the report of Mr. Brewer. Prof. G. F. Becker, of the U. S. Geological Survey, has recently made an examination of the gold fields of the Southern Appalachian as far south as Georgia, and while his examinations did not extend actually into Alabama, his descriptions apply with almost equal force to the Alabama fields. In the other states to the north-west of us, however, there seems to be a much larger proportion of the gold associated with the igneous rocks or with the schists derived from them than is the case in Alabama.

Since the report of Mr. Becker upon the Gold Fields of the Southern Appalachians* embodies modern views upon the structure of the rocks, the character of the veins, etc., I have thought it desirable to give below an abstract of some of his conclusions, which appear to me to be possibly applicable to our Alabama measures.

Structure of the Associated Rocks.

In Alabama, as well as in the south-eastern states, the

*Sixteenth Annual Report of the Director of the U. S. Geological Survey.

structure of almost the entire mass of the older rocks is schistose, the strike of the planes of cleavage being generally that of the Appalachian range, or N. 30 deg. to 50 deg. E. Where sedimentary strata occur they too strike in approximately this direction, in consequence of the folding which has built up the range; and as a consequence of this fact, the cleavage of the schists has very often been mistaken for bedding. The dip of these schists is generally towards the south-east, though occasionally, north-west, as well as other abnormal dips, occur. These remarks apply to the more prominent surfaces of schistose cleavage, but observation will generally show that there are schistose partings at a large angle to the most pronounced one, and when the two are about equally developed, their intersection being nearly horizontal, the strikes of each are approximately the same. Occasionally there are other schistose cleavages striking nearly at right angles with the predominant cleavage, but these play a comparatively unimportant part. According to modern views, massive igneous rocks such as granite, as well as stratified rocks, are converted into schists by the development of planes of cleavage by shearing, i. e., "by the sliding of each of the parallel infinitely thin lamellæ, of which the rock may be considered to be made up, upon that next below it, in the same direction and by the same infinitesimal amount," the movement being distributed over an infinite number of surfaces and not reaching the rupturing strain on any one. If the rock is not very uniform in composition, some portions of it may acquire the schistose structure before others, and the resulting schist will show bands or sheets in which different degrees of schistosity will be exhibited. If the deforming movement be carried far enough, fissures will be opened in part of the schist and carunculated surfaces or puckered surfaces will result, whilst other portions of the schist will have

merely flat cleavage surfaces. It is in such unevenly deformed rocks that fissures have opened most widely and veins are most abundant and widest. "Carunculated surfaces are therefore properly regarded as favorable indications by the miners."

Prof. Becker finds proof that the opening of the fissures now filled with ore took place later than the movements which rendered the country schistose, in the fact, among other things, that angular fragments of schist are often enclosed in the quartz; on the other hand the connection of the ore deposits with dikes does not appear to be very close, but coeval on structural grounds, since neither the ore deposits nor the dikes have been greatly disturbed since their formation. The observations of Prof. Becker show that in the great majority of cases the fissures follow the schistose partings somewhat closely though not accurately, showing a certain degree of correspondence between the producing forces of two. Nevertheless the movements were not in general identical in direction. This is shown first in the existence of veins and fissures at various angles to the schistose surfaces, and secondly, in the circumstance that some of the markings produced in the dislocations accompanying the opening of the fissures, do not coincide in direction with the motion which produced the schistosity. Again, where the rocks are schistose and the main ore bodies are intercalated, stringers almost always cut into the walls. From the relation of these stringers to the planes of cleavage of the schists it is inferred with a reasonable degree of certainty that the opening of the fissures has been accomplished by *normal* faulting, while the cleavage of the schists has been the result of *overthrust* or *reverse* faulting; in other words, the movements producing the schistosity and those producing the fissures have been in opposite direction though approximately along the same planes

The Veins.

As has already been said, the ore deposits of Alabama show approximate conformity with the structure of the wall rocks, and for this reason have often been described as bedded veins, and veins of segregation.

As shown by Prof. Becker, the structure with which the deposits are approximately conformable is not stratification, but schistose cleavage, which he also shows to have been produced prior to the movements which opened the fissures, and further, the pressures which opened the vein fissures did not in general coincide in direction with those which had previously produced schistosity. The result of the dislocation was to produce lens-like openings along the main cleavage of the rocks, which were subsequently filled with quartz, forming what he terms lenticular stringers. These stringers are often discontinuous, one dwindling away or disappearing while its place is taken by another in the foot or hanging wall. In many instances diagonal seams may be seen to connect such imbricating stringers, and where the connection cannot actually be seen it is nevertheless inferred to exist, and the conclusion is reached that all the stringers were once united by cracks sufficiently large to permit the passage of solutions. Such connected groups of veins have been termed by Prof. Becker "linked veins," and the association of small fissures, each bearing a lenticular mass of quartz, he calls a *stringer lead*.

While the greater part of our Alabama Gold deposits correspond to the stringer lead type, yet there are numerous small cross fissures. Instances of this are given by Mr. Brewer, for example in describing the occurrences about Goldberg, on Crooked Creek. From what has been said, it will be seen that the stringer leads, while coinciding in general with the schistose structure

of the country, do not coincide with it in detail, and that they are of the nature of true veins, i. e., filling of pre-existing cavities. Instances are also numerous where the veins are attended by impregnations of the country rock to such a degree that it is mined and milled along with the material of the veins themselves.

As stated above, the connection of the ore deposits in Alabama with the dikes cannot be clearly made out, nor can it be said that a satisfactory explanation of the origin of the gold has been reached.

The Placers.

The loose materials carrying the gold in the Southern Appalachians is, according to Prof. Becker, of two kinds, viz., the ordinary stream gravels, and the accumulations of rotten rock in place. To this latter, he proposes to give the name of *saprolite*, as a general term for thoroughly decomposed, earthy, but untransported rock. The celebrated Arbacoochee placers illustrate this term very perfectly.

Mr. Brewer's report above gives full details of the placers which have been worked in Alabama, and nothing further concerning them seems called for here.

B. NOTES ON THE MICROSCOPIC CHARACTERS OF THE ALABAMA CRYSTALLINE OR METAMORPHIC ROCKS.

1. Notes by Dr. G. W. Hawes.

The first attempt to study the rocks of Alabama by means of the microscope was made by Prof. Geo. W. Hawes, then of New Haven, Conn., who prepared and described for the geological survey about 25 thin sections of crystalline rocks, sent to him by myself in 1875. I give below a list of the indentifications made by him.

No. 1. Hornblendic mica-schist, Columbus, Ga. (Quartz, orthoclase, hornblende, and biotite.)

No. 2. Graphitic mica-schist, Coosa county. (Quartz, muscovite, and graphite.)

No. 3. Garnetiferous mica-schist, Randolph county. (Quartz, muscovite, biotite, apatite, garnet.)

No. 11. Epidote schist, Clay county. (Epidote, mica, quartz, hornblende.)

No. 13. Hornblende schist, Chilton county. (Hornblende, quartz, orthoclase, oligoclase, ilmenite.)

No. 15. Hornblendyte, Tallapoosa county. (Hornblende, oligoclase, quartz.)

No. 17. Andalusite in hornblendite, Clay county.

No. 17a. Epidosite, Clay county. (Epidote, cyanite, staurolite.)

No. 18. Hornblendyte, Dudleyville, Tallapoosa county. (Hornblende, chlorite, epidote.)

No. 19. Graphitic quartzite, Coosa connty. (Quartz, graphite.)

No. 20. Diorite, Chilton county. (Hornblende, labradorite, titanic, iron, pyrite.)

No. 21. Dolerite, near Auburn, Lee county. (Pyroxene, labradorite, magnetite.)

No. 22. Ossipyte, near Ragan's Mill, Notasulga, Lee county. (Labradorite, chrysolite, hypersthene, titanic iron.)

No. 23. Dolerite, Oak Bowery, Chambers county. (Pyroxene, labradorite, magnetite.)

No. 24. Granulite, Coosa county. (Quartz, feldspar, garnet, epidote.)

No. 25. Hornblendite, Wood's Copper Mine, Cleburne county. (Hornblende, quartz, feldspar.)

During the winter of 1892, Dr. J. Morgan Clements, at that time assistant geologist of the Alabama Survey, made a trip through the territory of our crystalline rocks with the purpose of collecting for microscopic examination typical specimens of the rock varieties most common in that section. The results of his work are given below. Other specimens collected by me were sent to him for identification and study later, in 1894 and 1895, and his report on these follows the article just referred to.

During the summer of 1895, at the request of Mr. C. W. Hayes, of the U. S. Geological Survey, I made a small collection of the crystalline rocks which have been examined by Mr. Alfred Brooks, of the U. S. Geological Survey, whose report appears below. Besides these examinations, Mr. Harry D. Campbell, of Lexington, Va., and Prof. Van Hise, of Madison, Wis., were kind enough to identify for me a number of crystalline rocks, about which there was uncertainty as regarded their origin.

It is the intention to continue these studies of our crystalline rocks, and to publish the result from time to time.

To the notes of Dr. Clements and Mr. Brooks I have added in foot notes such comments as to the associations and distribution of the several varieties described, as have seemed desirable.

2. NOTES ON THE MICROSCOPICAL CHARACTER OF CERTAIN ROCKS FROM NORTH-EAST ALABAMA.

BY

J. MORGAN CLEMENTS.

MADISON, WIS., Dec. 18, 1895.

Dr. E. A. Smith,
State Geologist, Tuscaloosa, Ala.

DEAR SIR:—I send you herewith a brief description of the rocks collected by me during the ten days spent in December, 1892, in the crystalline area of Alabama.

Immediately upon returning from the reconnoissance chips were sent away to be sectioned, but owing to unavoidable delays the sections were not received until nearly six months thereafter. My acceptance of a position elsewhere and entrance upon my new duties almost immediately prevented my completing the work begun on the Alabama Survey.

It has been a source of much regret that other duties have prevented me from sending you ere this the description of the rocks which through your kindness I was enabled to collect.

Very respectfully,

J. MORGAN CLEMENTS.

CONTENTS.

INTRODUCTION.

The rocks examined were collected by me for the Alabama State Survey during ten days spent on a reconnoissance trip in the north-eastern part of the State. It was primarily my object to visit and collect specimens for study from certain igneous rocks observed by Tuomey* E. A. Smith,† and C. H. Hitchcock,‡ and in general to collect specimens of the various crystalline rocks met with, in order that, from a study of the sections, I would be better prepared to undertake the mapping of the area which was contemplated as the work for the following season. The following is really a brief account of the journey, embodying all observations made, with the addition, however, of the notes on the microscopical characters of the rocks collected.

At the end, under the head of conclusions, I have arranged the rocks according to their probable origin, since, in view of the investigation now in progress in the crystalline area, the origin of its rocks is of great importance as indicating the relations to the overlying sedimentaries. It is this line of microscopical inquiry in conjunction with stratigraphical work which will probably be most fruitful in determining whether or not there is an Algonkian series of sediments—more or less metamorphosed—present in Alabama, or whether all the

*Second Biennial report of the State Geologist of Alabama, pp. 51, 61, 63, 1858.

†Observations of Profs. Smith and Hitchcock may be found in their manuscript notes.

‡A hand specimen of the rock mentioned by Prof. Tuomey on p. 51 of his second report, was found in the University collection with his label attached. This was submitted to Prof. Hawes, and by him described as *Ossipyte*: see his No. 22 above. Neither Prof. Hitchcock, Dr. Clements nor myself has succeeded in finding this rock in place.

E. A. S.

crystalline rocks are to be grouped with the Archæan.

Many of the rocks have been affected to a considerable depth by the atmospheric agencies. Frequently they will retain their structure quite perfectly, but when one attempts to collect a specimen the mass crumbles in the grasp. When the rocks have been subjected to active erosion and this thick weathered portion has been removed they will be found to be covered only by a thin altered layer and to compare in freshness with similar rocks from other regions.

An attempt was made to locate all ledges from which specimens was taken, by the sections, townships and ranges, but this proved a failure. In most cases the farmers do not know, or at least were very uncertain as to the section and portion of the section in which they were located.

Notasulga to Ragan's Mill.

Notasulga, where the first stop was made, is built on the light colored sand and gravel of the Lafayette formation, which covers the most of the Coastal Plain of the Southern States. For a mile north of this point the road to Ragan's Mill, Sec. 32, T. 19 N. Range 24 E., passes over this light colored soil. The change is then noticed to the red clayey soil of the crystalline schist area. About ½ mile before reaching the mill, we pass over very rotten mica schist striking N. E. and S. W. and dipping about 45 deg. N. W. Just before reaching the old mill-race, rotten mica schists outcrop again, and have interbedded with them a bed of quite fresh dark green, rather coarse grained schist, Sp. 1, 8 inches thick, striking N. E. S. W. and dipping to the N. W.

Sp. 1. *Amphibolite.*—The hand-specimen shows a vein of quartz which is parallel to the schistosity. Under the microscope the rock is seen to be composed of common green hornblende in interlocking prisms, with a very

small amount of quartz, in grains, associated with it. The hornblende shows marked pleochroism, with the usual absorption, *a*. yellow, *b*. yellowish green, *c*. bluish green, where $c \triangleright b \triangleright a$. It includes only a few round blebs of quartz. The prisms of hornblende lie with their longer axes in the same general direction, giving a marked schistosity to the rock. There is nothing which gives any clue at all to the origin of the rock.

Several bands of garnetiferous mica-schist are exposed in the banks of the mill-race. The bands strike S. E.-N. W. and dip to the N. W. Numerous small pegmatitic dikes were seen cutting these schists and intersecting each other. One dike of granite, $1\frac{1}{2}$ feet wide, has forced its way in between the strata. Immediately under the bridge the strata are contorted at a point where this granite intrusion shows marked increase in thickness.

Across the race, in the stable yard of Mr. Jones, the schists have a strike N. E.-S. W., with a dip to the N. W., the amount, however, not being determinable, as it was only a surface outcrop. These schists form the knoll upon which the house is built. The schists are here cut by a granite dike, Sp. 32. The rock is light, nearly white, and quite fine grained.

Sp. 2. *Biotite Granite*.—The microscope shows a rock with typical granitic structure and consisting of quartz, microcline and an unstriated feldspar which is presumed to be orthoclase, plagioclase, and biotite as essential constituents, with apatite, garnet, zircon, and rutile present as accessory minerals. As secondary minerals we find epidote and muscovite. The quartz is the ordinary granitic kind, containing both gas and fluid inclusion, the latter frequently with a dancing bubble. Long needles of rutile are rather common in it and zircon is also found enclosed by it. Microcline, which forms the greater part of the rock, is also present in xenomorphic grains and encloses blebs of quartz. It shows the char-

acteristic cross-hatched structure and commonly contains the spindle-shaped microperthitic intergrowths of a triclinic feldspar. Very little orthoclase is present in unstriated grains. Its place seems to have been taken by the microcline. The orthoclase encloses rutile and apatite. Plagioclase is also rather rare in partly automorphic crystals polysynthetically twinned according to the albite law. Biotite is found in fairly well developed crystals whose contours are, however, at times indented by the other minerals, and whose edges are in places quite ragged. The pleochroism is strong, sections cut parallel to the *c* axis varying from brownish yellow to dark, almost opaque brown. It is beginning to alter on the edges to muscovite. No magnetite was observed in this section. Apatite is in small crystals and is not common. Zircon is rather rare. Rutile occurs in fine needles in the quartz and orthoclase. A light pink garnet without crystal faces was also found in the section. A few garnets are also to be seen macroscopically in the hand specimen. Slightly pleochroic epidote was observed in imperfectly automorphic crystals, usually associated with biotite. All of the minerals are quite fresh, no traces of alteration being observed except in the biotite, which alters to muscovite, and a cloudiness along the edges of the feldspar grains and in cracks traversing them. The order of crystallization is first the accessory minerals, then biotite, plagioclase, microcline, and quartz. The granite shows evidences of dynamic action to a slight degree in the undulatory extinction observed in certain of the quartz grains and in the bending of the twinning lamellæ in some of the feldspars.

Beyond Mr. Jones' house, just before crossing the Sougahatchee Creek, we pass an exposure of rotten micaceous schist with the usual N. E. and S. W. strike and N. W. dip. A somewhat schistose granite rock, Sp. 3 and 4, is seen to form the hill across the creek.

Sp. 3. *Biotite Granite*.—This is macroscopically a light colored, slightly greyish, medium grained rock, showing a banding caused by alternating layers of rock material which are richer and poorer in dark mica.

Under the microscope the rock is seen to be composed of essentially the same minerals as the granite, Sp. 2 above described. Moreover the structure is the same except that a scarcely noticeable parallel arrangement of the mica plates exists, and a general agreement in the long extension of the grains of feldspar and quartz can be seen. In Sp. 3 the mica, which is the same dark brown biotite found in the granite, is in parallel intergrowth in places with a light colored mica muscovite, with strong absorption of the rays vibrating parallel to the cleavage. Neither the accessory rutile needles nor the garnet or epidote is present in the section. The feldspar begins to show alteration, with accompanying production of muscovite. The specimen also shows slight pressure phenomena.

Sp. 4. *Biotite Granite*.—This was collected by Prof. Hitchcock from the same locality, and is identical in every respect with Sp. 3.

I have called this rock a granite in spite of its slightly banded character. It might perhaps be more correctly called a gneissoid granite, for the succession of crystallization of these minerals and the microscopical character show it to be an eruptive rock. The question then arises as to the origin of the laminated structure in it which causes it to simulate a gneiss. The structure is original, for the dynamic action which the rock has undergone is very slight, as shown by the lack of a well developed cataclase structure. It seems reasonable to explain the lamination as the result of differential movement in the original rock magma. The great resemblance between Sp. 3 and 4 and Sp. 2 and their close proximity to each other leads me to suppose, although no connection be-

tween them was observed, that they are portions of the same rock mass. Upon closer study of the occurrence it will probably be found that the mass from which Sp. 3 and 4 were taken is either a great dike, or else a laccolitic mass from which the smaller dikes cutting the schist, such as the one from which Sp. 2 came, were sent out.

According to Tuomey there occurs at Ragan's Mill a dike of gabbro. (2nd Biennial Rep. State Geologist of Ala., 1858, p. 51). This dike was sought for by Hitchcock, but like myself he failed to find it. Hitchcock found, however, near the grist mill what he describes as a very modern looking basaltic rock. (Manuscript notes). At first sight the rock collected by Hitchcock also impressed me as resembling very closely certain young volcanic rocks. As it would be exceedingly interesting if such a rock could be found *in situ* occurring in the Appalachians, an especial search was instituted for it near the site of the mill, for the mill itself no longer exists, but failed to bring it to light. Under the microscope the rock is seen to be a basalt of exactly the same type as that quarried at Niedermendig, Rhenish Prussia, and exported extensively for use in America and elsewhere for millstones, and this was the rock to which it was referred when first seen. Without being able to state positively, it seems to me that the specimens collected by Prof. Hitchcock owe their origin to such an imported millstone, it probably having been broken up into fragments, so that he was not able to observe traces of workmanship upon it.*

The following is a brief description of the rock collected by Hitchcock:

Sp. 5. *Leucite Tephrite.*—This is a fine grained gray vesicular rock. Under the microscope its constituent

*In the summer of 1895. I collected specimens of this rock from the old mill race, and obtained positive proof that it formed part of a millstone imported many years ago by Mr. Ragan. Dr. Clements' conjecture as to its origin is thus verified. E. A. S.

minerals are seen to be augite, olivine (?), biotite, leucite, apatite, and magnetite. Augite occurs in porphyritic minerals and also in very small grains in the groundmass, that is in two generations. In color it is yellow, with a very faint pleochroism. At times it is zonally arranged, with a green pleochroic aegirine-like pyroxene at the center and around it a zone of ordinary augite. It shows the ordinary characters, so frequently described, of basaltic augite. Biotite was present also in porphyritic crystals. Its former presence is determined by its form. Certain paramorphs after it, which retain the biotite form, now are made up of grains of augite and magnetite, the biotite substance having been completely resorbed by the magma. The augite and biotite crystals lie in a fine grained groundmass which consists chiefly of small augite crystals and magnetite, with leucite and plagioclase as feldspathic elements. The leucite shows no optical anomalies in the small crystals here present, but is isotropic. Its outline is marked by the characteristic zonal inclusions of augite, magnetite, and brownish glass. The plagioclase is in small polysynthetically twinned lath-shaped crystals. The magnetite forms well developed crystals of small size. Apatite is present in needles, and in one case a fairly large crystal which was quite full of black interpositions. Numerous grains in the groundmass which are colored yellowish brown by iron hydroxide may be slightly altered olivine, but I could not be sure that they were. Nepheline was sought for in the groundmass but was not found with the microscope, and no microchemical tests were made to prove its presence. Glass was likewise not found, although it is probably present as colorless films between elements forming the groundmass.

Notasulga to Wood's Mill.

A short visit was made to a small quarry to the north.

west of Notasulga, which can be found on the right-hand side of the road about 350 paces in the woods, ¾ mile before reaching Wood's mill. The quarry is abandoned and pretty nearly full of water.

Sp. 6. *Biotite Granite*.—Microscopically the rock is medium grained, gray, and does not show in the hand specimen a gneissoid structure. This is only seen in the rock *en masse* in the quarry, the banding striking N. E. S. W. and dipping 5 deg. S. W. There is a parting which runs parallel with the bands and separates the rock into massive layers. This parting greatly facilitates quarrying.

Under the microscope it is found to be composed of quartz, microcline, orthoclase, plagioclase, biotite, muscovite, and very little magnetite. Apatite and zircon are present as accessory minerals. These minerals all possess the usual characters as described above. The mica is the ordinary brown biotite, showing the absorption, and also muscovite. This latter is frequently seen in parallel intergrowth with the biotite. There is an easily recognizable absorption in it of the rays vibrating parallel to the cleavage, giving it a faint greenish tinge. Some of the minerals show traces of beginning alteration. In the feldspar this slight cloudiness is the beginning of kaolinization. Some calcite, probably infiltrated, was also observed in the section. Undulatory extinction was rare. The rock bears great resemblance microscopically to Sp. 3 and 4 from Ragan's Mill, and it is highly probable that it belongs to the same rock mass.*

Auburn to Mr. Drake's.

One mile north-west of Auburn, in Sec. 19, T. 19 N.,

*To this same rock mass belongs also very probably, the granite described by Mr. Brooks below from 3 miles west of Loachapoka.
E. A. S.

R. 26 E., near Mr, Drake's farm, a quarry in gneiss was visited. The schistosity strikes north-east and south-west and dips 20 deg. south-east.

Sp. 7. *Biotite Gneiss.*—A fine grained dark gray schistose rock very rich in biotite. The microscope shows quartz, plagioclase, orthoclase, biotite, muscovite, and magnetite to be the chief constituents. As accessory minerals garnet, zircon and thulite were observed. The minerals quartz, feldspar and mica are in grains and ragged fragments, and consequently show no well defined order of crystallization. The mica lies between other minerals with well marked parallelism of the long extension of its plates, and gives the rock its schistose structure. Zircon is included in the biotite, and the biotite immediately surrounding it has a very much stronger absorption than elsewhere. A few small crystals of rose-colored manganiferous zoisite—thulite—were found. One was seen included in biotite, and like the zircon surrounded by a pleochroic court. The remaining minerals present their ordinary characters. The rock is quite fresh, slight kaolinization of the feldspar being the only alternation which is shown. It has, however, undergone considerable crushing, to judge from the bending of the mica and undulatory extinction in the minerals. This has even gone far enough to produce an imperfect cataclistic structure. Nothing could be seen indicating the mode of origin of the gneiss, though the crushing might lead one to suppose that it was a metamorphosed eruptive, perhaps originally a biotite granite.

Auburn to Wright's Mill.

A search was made along the road running towards Wright's Mill, south-east of Auburn, for a dike of diabase observed by Dr. Smith, and found about three miles from

the town. I was unable to find the dike and get its relation. The following is a description of the hand specimen collected by Dr. Smith :*

Sp. 8. *Diabase.*—A medium grained dark gray rock, showing macroscopically the arrangement of the feldspar laths. It alters to a light brown product which covers part of the specimen with a thin crust. The rock is a typical diabase, with a beautifully developed ophitic structure. It is composed of plagioclase, quartz, augite, some greenish brown mica, and titaniferous magnetite. The plagioclase is in automorphic lath-shaped crystals and predominates in the section. The angular interspaces between these crystals are filled with the augite, magnetite, and ilmenite. The feldspar is quite fresh, and is twinned both according to the albite and carlsbad laws. Measurements of the extinction angles against the twinning planes gave angles varying from 25 deg. to 36 deg., showing it to be a variety of labradorite. The augite, twinned according to the usual law, is found in xenomorphic crystals between the feldspars. It is light yellowish in color and quite fresh. At times a beginning alteration to a greenish chloritic substance is seen around the edges. A small amount of diallagic augite in small grains has in some cases been almost entirely changed to this substance. The greenish alteration product has a very finely fibrous structure, and seems to be due to a process of serpentinization rather than to uralitization. This also fills some of the angular spaces in the rock, and may indicate total alteration at such places of the originally present augite. No olivine is present. Only a small amount of quartz was observed, and it was in micropegmatitic intergrowth with the feld-

*This is the same rock as that identified by Dr. Hawes as Dolerite, No. 21 above. At present the name dolerite is applied to the more recent and diabase to the older eruptives of similar composition.

E. A. S.

spar, this forming the last product of the crystallization. It fills in a few of the angular interspaces. There is not enough present to cause the rock to be called a quartz diabase. Considerable leucoxene, the alteration product of ilmenite was observed around the iron ore. Some secondary crystals of iron pyrites were also found.

About half way between Auburn and Wright's Mill we cross an outcrop on the top of a hill of quartz-schist.

Sp. 9. *Quartz-schist.*—A white, very fine grained rock, almost novaculitic in texture. It weathers slightly and the weathered surface is tinged red. The schistosity of the rock is marked by the presence of plates of muscovite lying parallel to each other. Under the microscope the rock is seen to be composed chiefly of interlocking grains of quartz. Feldspar in similar grains which show up best when altered, and muscovite in parallel leaves are common. A few rutile needles, zircon crystals, and some iron pyrites are the only other minerals present.

Just before reaching Wright's Mill we pass an outcrop, striking north-east and south-west across the road, of augen gneiss, Sp. 10, which, when very much altered, looks like talcose mica-schist, Sp. 11. The same rock outcrops at the mill in the bed and banks of Chewacla Creek. In the creek bed, just above the mill, we find a thinly bedded finer grained variety, Sp. 13, interbedded with a commoner variety like Sp. 12, which is in its turn merely a finer grained variety of Sp. 10. It is highly probable that the thin bed is only a portion developed along a shearing plane. The strike of the rocks as taken on the contact between the finer and coarser grained variety, Sp. 13 and 12, is N. E.–S. W., with a dip of 60 deg. S. E. These rocks are especially interesting, as showing so clearly the origin of their present structure.

Sp. 10. *Biotite-gneiss.*—Probably derived by dynamo-

metamorphic action from an original biotite granite. Macroscopically it is a typical "augen" biotite gneiss, with a well marked oval augen around which the mica layers bend.

Under the microscope the eyes are composed of feldspar, both polysynthetically twinned and an unstriated kind, quartz, and biotite. The association is granitic, the biotite and triclinic feldspar showing the best development. All the minerals are very fresh. The feldspar is full of minute automorphic crystals of epidote, and zoisite, and contains also small plates of muscovite. The feldspar substance between these minerals is perfectly fresh, showing no trace whatever of alteration. The feldspar shows only slight undulatory extinction. The quartz between the feldspar is, however, already crushed, and is present as an interlocking mosaic. Surrounding the eye there is a zone of varying width composed essentially of minute brown biotite scales with a few larger biotite and muscovite plates lying in a mosaic of crushed quartz and feldspar. Imbedded in the mica are large sphene and epidote crystals. In one case a brown allanite crystal was observed surrounded by epidote, as described by Lacroix* from several localities, and by Hobbs† from the Ilchester granites of Maryland. The sphene and epidote crystals lie with their long extension parallel to the schistosity of the rock. Also a little pink garnet was seen. These and the mica are evidently secondary. They show no sign of crushing. In this biotitic portion there are also minute eyes formed of single oval feldspar crystals surrounded by a mosaic of

*Contributions a l'étude des gneiss a pyroxene et des roches a wernerite. Bull. de la Soc. francaise de Mineralogie, tome XII, No. 4, April, 1889.

†On the Paragenesis of Allanite and Epidote as Rock-forming Minerals, by Wm. H. Hobbs. Johns Hopkins Univ. Circulars, No. 65, April, 1888; Am. Journ. Sci., Vol. 38, Sept., 1889, pp. 223-228; Tch. Min. Pet. Mit., Vol. 11, 1889, p. 1.

small grains of feldspar ground from the large crystals by crushing. The quartz seems in all cases to have been ground down to what we may call a miscrocopical powder, so fine are the grains at times, and this forms the most of the material in which the biotite flakes lie. The specimen shows the phenomena accompanying crushing and shearing most beautifully. The crushing of the quartz is especially well shown. From a large grain showing undulatory extinction the process can be traced to the next stage, where the grain is separated along lines perpendicular to the direction of schistosity. These various edges and also the ends around the outer edges and corners are then rubbed to a finely powdered mosaic of quartz, and in the last stage we have none of the original quartz left in large grains. The feldspar likewise is crushed, but it is usually first rounded by the grinding down of the corners, reducing it to a more or less oval outline. It is also frequently pulled apart and the cracks, extending perpendicular to the direction of movement, have been filled with quartz. Judging from the eyes, which apparently represent the original rock, this biotite gneiss seems to have resulted from the intense crushing of a biotite granite.

Sp. 11. *Biotite-gneiss.* This is a very much altered phase of the above. In it muscovite forms the greater part of the rock, and there is a great deal of ilmenite in well developed hexagonal plates. No epidote and very little sphene is present.

Sp. 12. *Biotite-gneiss.* This is a somewhat finer grained modification of Sp. 10. Instead of epidote we have, however, the rose colored manganiferous zoisite—thulite—appearing in rounded prismatic crystals. It is always surrounded by a narrow zone of clear white zoisite. The minerals have not in all cases exactly the same orientation, the extinction varying very slightly in

the two zones. The thulite has even a lower polarization color than the zoisite, appearing almost isotropic. The occurrence of thulite in biotite-gneiss, noted also in Sp. 7, has, as far as I know, not been mentioned before. Its zonal structure with zoisite is especially interesting. The manganese present in the rock having been used up, the mineral continued to grow by the addition of the zoisite molecule. This zonal structure of the zoisite and thulite may be compared to that described by Lacroix and Hobbs* in the case of allanite and epidote intergrowths. Apatite is present in a few crystals.

Sp. 13. *Biotite-gneiss*, does not differ from No. 12 except in that it is a trifle finer grained and contains rather more muscovite.†

Below the mill there are outcrops in the creek under the bridge and along the road beyond the bridge of a pinkish quartz-schist. I was not sure of the true bedding.

Sp. 14. *Quartz-schist.*—This quartz-schist is almost exactly like Sp. 9, showing, however, a greater degree of alteration. The muscovite is not in such large flakes as in the last specimen, and in general the rock is somewhat coarser grained.

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*l. c.

†The augen-gneiss (biotite-gneiss) here desribed, numbers 10, 11, 12, and 13, occupies a belt four or five miles in width, that may be followed from the vicinity of Auburn northeastward to the Chattahoochee river, where its northern boundary is a little north of Mechanicsville, and its southern limit to the south of Wacoochee creek. In all this belt the several phases in the atmospheric decay of rock may be followed out.

In one stage the result of the alteration resembles very strongly a talcoid mica schist, such as is mentioned by Dr. Clements; this in turn passes into a purple or reddish clays somewhat like the clays characteristic of the Tuscaloosa formation of the Cretaceous.

The dolomite and quartzites of the Chewacla belt occupy a place in the midst of these gneisses, the dip of the gneiss being in both directions from the dolomite belt as though it were upon an anticlinal fold.

Mr. Brooks has also described specimens of the same rock from the same locality, Nos. 15 and 16. E. A. S.

Lafayette to Oakbowery.

Near Mr. Bledsoe's, Sec. 35, T. 22 N., R. 26 E., S. W. of Lafayette on the road to Oakbowery, a mass of rock is exposed striking across the road.

Sp. 15. *Diorite.*—This rock is dark gray, coarse grained, and imperfectly schistose. The minerals forming it are common green hornblende, pyroxene, feldspar, sphene, epidote, and magnetite. These show the usual characters of such minerals. The amphibole is perfectly compact and occurs in grains rather than in crystals. It shows a strong pleochroism, *c*. deep blue green, *b*. yellowish green, *a*. yellow. The pyroxene is a green malacolitic pyroxene, with scarcely noticeable pleochroism from light green to a slightly yellowish tinge of green. It is not present in any better developed forms than the amphibole. It is found in parallel intergrowths with, and also included in, the hornblende. Along the edges it is in places seen to be slightly fibrous, but no other trace of alteration was observed. Careful search was made for evidence of the secondary nature of the hornblende, that is, that it was the result of the alteration of a pyroxene, as has been so frequently described. Its relations to the green pyroxene, including it, seem to favor the idea of its formation from it, the included pyroxene grain representing an unaltered core. No proof of this could be found. The almost perfect freshness of the minerals is itself against it. I could only come to the conclusion that the amphibole and pyroxene are both original.

Both plagioclase and orthoclase are present, the former predominating. Neither possesses crystal outlines, though the plagioclase approaches automorphism most closely. Quartz is present in very small quantity in xenomorphic grains. Sphene is present in numerous small rhombs included in all of the other minerals. Mag-

netite occurs in a few rare grains. The extinction in all of the minerals is sharp, indicating a total absence of dynamic action. The epidote is of quite a different character from what has usually been observed. It is not found in crystals, but as a fringe or zone between the feldspar and hornblende. This fringe is not composed, however, solely of epidote, as is the case in the zone described by Williams,* but of epidote micropegmatitically intergrown with a clear white mineral of rather low single and double refraction. This mineral penetrates the epidote in curving rods, which branch, giving V shaped forms, and have in cross section rounded or irregularly long oval outlines. By changing the focus of the instrument the rods can be followed as they curve and run out without any break to join the feldspar, to which they evidently belong, since they extinguish with the feldspar. The feldspar forms perhaps one-third of the entire mass of the fringe. The epidote has in hand specimen a green color, and under the microscope a greenish yellow tinge without marked pleochroism. It has the high single and double refraction and rough surface of epidote, but no crystal outline. In no case could a figure be obtained in convergent light, probably owing to interference of the intergrown feldspar. No cleavage was observed. In fact, while the statement has been made that the mineral is epidote, no absolute proof can be brought forward to show that it is—no separation and chemical analyses as yet having been made of it. The contact between the epidote and hornblende is fairly sharp. The epidote is at times more or less surrounded by hornblende, but the immediate contact line is sharp.

A case like this was figured by Hobbs† from a gabbro

*The Gabbros and Associated Hornblende Rocks of Baltimore, Maryland, G. H. Williams, Bull. 28 U. S. Geol. Sur., 1886, p. 32.

†Some Metamorphosed Eruptives of Maryland, by Wm. H. Hobbs. Trans. Wis. Acad. Sci., Arts & Letters, Vol. 8, 1890, Fig. 1, p. 157.

diorite from Ilchester, Maryland. The micropegmatitic intergrowth, however, is not mentioned in the text, and but imperfectly represented in the figure. Through the kindness of Mr. Hobbs I was enabled to examine the section figured, and was thus able to satisfy myself of the similarity of the two occurrences, the one from Alabama being a much more perfect case, and the rock in which it occurs being far fresher than the Maryland specimen. In the article referred to the conclusion seems to be that, as suggested by Prof. Rosenbusch, "the mineral is amphibole in thin scales, the high colors resulting from intercalated films of air." This explanation could not be considered at all for the Alabama occurrence, as the mineral is seen to be perfectly compact and occupying the entire thickness of the section. However, as showing an excuse for the suggestion of the hornblende nature of the mineral, it may be mentioned that I found in one case, in Sp. 15, a micropegmatitic intergrowth of feldspar and hornblende on the edge of a large hornblende crystal, which bears a great resemblance in certain positions to the epidote. As soon, however, as the stage was revolved, the marked emphibole pleochroism became apparent, and agreed perfectly with that of the main mass of the crystal, and the cleavage could be followed extending from the compact main crystal through the micropegmatitic portion. Moreover the interference colors are not so high as are those of the epidote.

In the cases of the epidote occurrences cited above by Williams and Hobbs (l. c.), they have been explained as reactionary rims between the feldspar and hornblende. Both rocks from which they have been derived have been much altered, and have clearly been derived from other rocks by dynamo-metamorphism. The one I have before me is, as above stated, perfectly fresh. Moreover, it has not been subjected to dynamic action, as is shown by the sharp extinction of all the mineral constituents. The

position of the epidote proves it to be dependent for its origin upon the feldspar and hornblende. No evidence can be found in this specimen to support the view that the fringe was secondarily formed by a reaction between the feldspar and hornblende as a result of metamorphic action, however, for the rock has apparently undergone no such metamorphism. Since there is an absence of proof of its secondary nature, may we not, with some degree of probability at least, consider this micropegmatitic epidote fringe to be due to a somewhat similar process and condition as that existing during the formation of the well known micropegmatitic intergrowth so frequently seen around feldspars in the acid porphyries, the reaction upon each other of the feldspar and hornblende molecules remaining uncrystallized at a certain time resulting in a mineral of intermediate composition, the epidote, penetrated by the fresh clear rods of feldspar.

At the foot of the hill just before reaching Mr. Andrews's house, there outcrops on the right of the road, forming a small elevation, a coarsely granular rock, Sp. 17. This is also seen on the opposite side of the road outcropping in several small knolls, the general trend of the rock mass as indicated by the series of knolls being S. E.–N. W. Sp. 18 was taken from one of the knolls right by the negro cabin. As we ascend the hill upon which Mr. Andrews's house stands, we pass over light greenish, rather fine grained schist, Sp. 15, with schistosity striking S. E.–N. W. It is cut by six dikes, Sp. 19, from six inches to fifteen feet in width, which are very much altered, and now consist for the most part of chlorite. Prof. Tuomey says of the exposures:* "Near Mr. Andrews's house, vast and rugged masses of hornblende passing into soapstone are found protruding above the surface and not far from the house

*2d Biennial Report of the State Geologist, 1858, p. 61.

a trap dyke crosses the road, with which I found associated magnetic iron but not in great quantity."

Sp. 16. *Amphibolite* (*Hornblende-schist*).—This is a moderately fine grained light green schistose rock composed of common green hornblende, with magnetite inclusions in small quantity. No quartz or feldspar is present. The amphibole shows moderately strong pleochroism from light green to yellowish white. The extinction is sharp and the angle measured against the prismatic cleavage is low, the maximum of several measurements being 13 deg. A few of the crystals are colorless at one end and green at the other. Such crystals possess, however, the same optical characters throughout. Where the magnetite occurs it is always fresh. The rock in no wise indicates the manner of its origin or from what derived. It resembles very much Sp. 28 and 29 from West Point, Ga.

Cutting this schist we find, as first stated, Sp. 19, but as this is merely an altered phase of Sp. 18 and 17, they will all be described together and the process of alteration traced out. Although the large masses from which Sp. 17 and 18 were taken were not observed in contact with the schist, we may reasonably conclude, from the fact that they are igneous rocks, and the same as Sp. 19 which does cut the schist, that they would bear the same relations to it, if the rock was sufficiently exposed to allow the relations to be discovered.

Sp. 17, 18 and 19. *Hornblende Olivine Rock* (*Cortlandite*).—This is a coarse grained rock with dark green color, which upon weathering is covered wfth a ferruginous crust. It is a granular aggregate of hornblende, olivine, pleonaste, and magnetite. The hornblende differs from that usually found in such rocks in that it is a very light green, so that in thin sections it appears almost colorless, whereas in the rocks for which Williams*

*Peridotites of the Cortland Series, by G. H. Williams, Am. Journ. Sci., iii, vol. 31, 1886, p. 30

proposed the name *cortlandite* the hornblende was the brown strongly pleochroic variety. The hornblende angle and other characters prevent its being mistaken for a pyroxene. It is present in partially automorphic long prismatic individuals and is quite free from inclusions, only in a few cases containing magnetite and minute brownish plates. The olivine is in large grains between the hornblende crystals, and is for the most part altered to yellowish serpentine. Grains of unaltered fresh olivine still remain scattered through the serpentine. It contains a good many magnetite inclusions and also grains of green spinel. The light green isotropic mineral which is present in considerable quantity in irregular grains throughout the rock is a spinel and is presumed to be the iron-magnesia aluminate, pleonaste. It is usually associated with the magnetite, and is frequently seen forming a narrow rim completely or partially encircling it. This also contains numerous small crystals of magnetite. Magnetite is present in large crystals scattered through the rock, besides that enclosed in the other minerals. The secondary products are serpentine, chlorite, and calcite. The amphibole alters along cleavage lines and fractures to serpentine, and in places also to a chloritic mineral which is light green for the ray vibrating parallel to the cleavage, and yellow perpendicular thereto. The olivine alters to the characteristic serpentine with mesh structure.

Of considerable interest is the alteration which the green spinel undergoes. It shows in places an imperfect octahedral cleavage. Along these and fracture lines and around the edges it slightly alters to a white to brownish yellow substance in which still remain the magnetite crystals which are included in the fresh mineral. This substance by high power appears in places somewhat fibrous and seems to have at times a low polarization color and at others to be isotropic. The doubly refract-

ing portion is presumed to be serpentine, a product which might readily be formed from such a ferro-magnesian alumniate. The isotropic portion is not determinable. So far as I can learn, no such alteration has ever been described for pleonaste in any rock. The spinels are usually described as perfectly fresh in all rocks in which they occur. It is one of the most resistant of minerals, and in such rocks remains perfectly fresh after the other minerals have altered, Here, however, we have it beginning to alter, even before the olivine has completely disappeared. Moreover, in Sp. 19, the most altered phase of the rock, the spinel is quite fresh. It would appear to be due perhaps to some special cause acting in the larger dike alone, The alteration is best seen in Sp. 17, and there I believe no one can be in doubt as to its being a true alteration. In Sp. 18 it is not quite so far advanced. Shepard mentions a partial pseadomorph of steatite after a green spinel, containing chromium, from N. Carolina.*

Sp. 20. *Amphibolite* (*Hornblende-schist*). Immediately after crossing the first large brook beyond Mr. Andrews's I collected a specimen from a rock outcropping in a small mass to the right of the road. Could get no good strike of schistosity. The rock is green, schistose, and medium grained. Under the microscope it is seen to be identical in character in fresh condition with the preceding amphibolite, Sp. 16. As it begins to alter, however, there is a change in the character of the rock. The amphibolite begins to bleach, the bleaching beginning along the edges. As a result of this bleaching we have an amphibole formed which is very much lighter in character than the original, and occurs not in compact masses but in more or less fibrous crystals with green color. It shows very slight or no pleochroism and

*C. U. Shepard: Corundum of N. Carolina and Georgia. Am. J. Sci. IV. 113, 1872.

possesses the characters of actinolite. Grains of calcite and magnetite are observed intermingled with this secondary amphibole, and are looked upon as products of the decomposition of the common hornblende. The magnetite has collected in aggregates of varying size, and is usually surrounded by the actinolite, mixed with grains of calcite.

At Mr. Joel Harris's Sec. 4 or 9, T. 20 N., R. 26 E., I collected Sp. 21 from the brow of the hill back of the house.

Sp. 21. *Diorite.* This is a black schistose rock, which upon examination proves to be diorite. The hornblende is the common compact green variety, strongly pleochroic, *c.* bluish green, *b.* yellowish green, *a.* light yellow, and occurring in thick forms approaching grains. It has all the appearance of an original constituent. The feldspar, which is a plagioclase, is without crystallographic contours. This is accompanied by a few unstriated grains supposed to be orthoclase. All of the feldspar is very fresh, showing in a few cases beginning cloudiness. Very little quartz is present. Epidote is found in a number of large crystals. Of all the minerals it has the best crystallographic outlines, in every case one or more crystal faces being developed. Some magnetite is present included in all other minerals.

Sp. 22. *Diorite.* From large boulders in situ in Mr. Joel Harris' pasture. This is the same as above except that the epidote is wanting. The extinction in both of these sections is sharp, indicating total absence of orogenic pressure. The schistosity is given to them by the general parallelism of the hornblende prisms, causing the rock to cleave readily in a certain direction.

Lafayette to B. F. Frazier's.

Going west from Lafayette upon the Dudleyville road we pass, just before crossing the large branch of the

Hoodlethlocco creek, about a mile from town, an outcrop of a green dioritic rock like Sp. 15 and 21. This is weathered to a depth of several feet, the weathered product being a yellowish brown porous rock through which are scattered black spots of limonite and in some cases glistening grains of quartz. This alteration product is quite common along the road from Lafayette to Oakbowery and to Dudleyville, but this was the first time it was seen in connection with even a fairly fresh rock. Usually only the porous brown alteration product remains. Near B. F. Frazier's, the old Holloway place, a low outcrop of quite rotten hornblende olivine rock, Sp. 23, was visited. This I was told had been used for making mantels in a few cases by some of the people living there.

Sp. 23. *Hornblende Olivine Rock* (*Cortlandtite*). This rock is of a dark green color, coarse grained, with the brown colored hornblende appearing in large porphyritic crystals, each surrounded by a narrow zone of lighter colored mineral.

Under the microscope it consists chiefly of large crystals of hornblende, grains of olivine and magnetite as primary minerals, and actinolite, talc, and chlorite as secondary products. The hornblende, in large plates, having macroscopically a brownish or bronze color, shows microscopically a yellowish to yellowish green tinge, and is very weakly pleochroic. It contains olivine and magnetite inclusions. It bleaches around the edges and forms lighter colored green amphibole. The alteration of the compact hornblende to the fibrous actinolite is very beautifully shown. With the alteration there follows the reduction of the extinction angle from 20° in the large plates to 18° in the fibrous actinolite surrounding it. It also alters to talc. The olivine is in large grains and contains magnetite and also some hornblende inclusions. It is remarkably fresh, beginning to

alter along the edges very slightly. The magnetite is in considerable quantity in grains, and is included by all original minerals. As can be readily seen, the fibrous hornblende is formed from the compact variety. There is a large amount of this present. Talc is frequently found surrounding the hornblende and in the large plates also penetrates it along fissures. In the fissures it contains magnetite, just as the serpentine veins in olivine do, and appears to be without doubt secondary after the hornblende. There is a large amount of it present in the rock. Chlorite is found, but in rather small quantity.

Perhaps this is the rock to which Tuomey refers when he states 'that about seven miles west of Lafayette a trap dike comes to the surface.'* This is about that distance from the town, but I strongly suspect that he observed some of the dark schistose dioritic rocks like that which I mentioned above, and termed it a dike, as farther on he speaks of this dipping to the southeast. The rock from which the cortlandite came is perfectly massive. On the same page he speaks of the same series of rocks outcropping on the road to West Point, Ga. I passed the brown, rotton, weathered product of the diorites outcropping on the road to West Point also, but but no massive dike rocks. This brown alteration product is quite common around Lafayette.

West Point, Ga.

While waiting for a train here I visited a place where, according to Tuomey,† as near as I could judge from the location given, an interesting trap dike was to be seen. I collected several specimens of the rock outcropping, and it may be well to describe the section, as the

†Second Biennial Report of the State Geologist of Alabama, 1858, p. 63.

*Second Biennial Report of the State Geologist of Alabama, 1858, p. 63.

same rock will probably be traced over into the Alabama territory.

In the first deep railroad cut on the east side of the Chattahoochee river there is an excellent exposure of crystalline rocks. They possess a certain degree of schistosity, the strike of which is uniformly NE–SW and the dip to the NW 60°. The rocks are very much altered, though some specimens were obtained which were quite fresh.

Sp. 24. *Diorite.* This is an especially coarse grained rock, and under the microscope is seen to be composed of common green hornblende and plagioclase, with small amounts of orthoclase, quartz, and magnetite. The minerals are xenomorphic, but the plagioclase seems to approach nearer to being automorphic than any of the rest.

Sp. 25. *Diorite.* This is a trifle finer grained than the preceding and is composed of the same common green hornblende, plagioclase, very little orthoclase and quartz, considerable apatite in round grains, and some pink garnet and also magnetite. The garnet is automorphic. None of the other minerals show crystallographic boundaries. The minerals are very fresh under the microscope. The magnetite is beginning to alter, and colors the adjacent minerals with yellowish brown iron hydroxide.

Sp. 26 represents an advanced stage of alteration of rocks similar to 25, but containing a good deal of quartz, the only mineral now remaining. Otherwise it is a mere network of isotropic brown iron hydroxide.

Sp. 27 is the most advanced stage of similar rock. No mineral is seen at all in this, the quartz having failed in the original or else having been washed out, leaving merely the porous clayey ochreous mass.

Sp. 28. *Amphibolite* (*Hornblende-schist*).—To the east of the coarse diorites there is exposed for nearly 150 feet a rock which is without stratification or marked schistosity. It is found mostly in irregular blocks separated by a sandy decomposition product. The rock itself has a rough sandy feeling. It is light green in color with a tinge of yellow. Under the microscope the rock is found to be made up of common green hornblende in irregular grains and prismatic crystals, and a monoclinic amphibole, colorless in thin section, which at times is intergrown with hornblende. A few grains of quartz were observed between the amphiboles. The rock is very fresh, and the decomposition seems to be merely a loosening of the grains, which allows the hornblende crystals to fall apart very readily. The two sections are very thick. It would be interesting to find out the relations of this rock to the rocks represented by Sp. 29 and 30, and thus determine its origin. I am unable to tell from the sections how the rock originated.

There occur interesting rocks. Sp. 29 and 30, exposed in numerous blocks on the surface above the railroad cut but not outcropping in the cut itself. These blocks are scattered along a ridge having its long direction extending approximately north-east and south-west.

Sp. 29. *Augite Norite or Hyperite.*—This is an exceedingly tough, medium grained green rock, which under the microscope has as constituents hypersthene, augite, hornblende, plagioclase, and magnetite. Hypersthene is in larger proportion than any other mineral and is present in short prismatic individuals without terminal faces. It is colored quite deeply and shows its characteristic pleochroism, *a*. red, *b*. yellowish red, *c*, green. Some but not all the crystals contain the reddish brown platy inclusions which are so frequently found in hypersthene. Fibrous green diallage is present in about equal quantity with the hypersthene. It is xenomorphic, and

some of its crystals contain brown inclusions. It may be easily distinguished from the hypersthene by its high extinction angle and lack of pleochroism. Both the hypersthene and diallage have a mottled appearance between crossed nicols. This is especially marked in the diallage. It is seen to be due to included microlites with light green tinge, which from their high extinction angle are supposed to be some pyroxene mineral. Owing to the great thickness of the slide and strong color of the enclosing mineral, the difficulty of determining the microlites is greatly increased.

Hornblende is present in very small quantity. It occurs in a partial rim around the pyroxene. It is light green in color, compact, and apparently an original mineral. The plagioclase is found in very small quantity and forms xenomorphic grains filling in the angles. In a few places larger plates of it enclose the hypersthene individuals, giving a poikilitic structure. It also contains numerous light greenish undeterminable microlites. No iron ores are present; all of the iron present in the original magma having apparently been used in coloring the various minerals. All of the minerals are very fresh. The structure of the rock is granular. The above described rock bears remarkable resemblance to some of those described by Williams* from the Cortlandt series of New York.

Sp. 30. *Pyroxene Hornblende Rock.*—Macroscopically this is quite similar to the preceding, but one can readily see that there is a larger proportion of the light green hornblende present. The components of the rock are hornblende, augite and magnetite. The hornblende is in zenomorphic individuals, is compact, and is a light green variety of the common hornblende. It is original. The augite occurs in large plates enclosing small hornblende individuals. It is also compact, of a pink color,

*Am. Journ. Sci., iii, Vol. 33, 1887, p. 193.

and with very slight pleochroism. Both the pyroxene and hornblende contain numerous inclusions of magnetite. In addition to these inclusions the magnetite also occurs in large crystals scattered through the rock. No feldspathic mineral is present, and the structure is granular. This is a peculiar facies probably of the same magma from which the norite is separated, as would appear from their intimate association.

These are exceedingly tough rocks, forming apparently the ridge extending north-east from the railroad cut. Along this ridge these boulders are found scattered in intimate association, though the relations of the one to the other could not be observed. There are several pits which have been sunk in search of copper at various points on the ridge, and it was probably from one of these that Tuomey collected the serpentine, Sp. 31. The sides of the pits have now caved in, or else have been otherwise filled with debris.

Sp. 31. *Serpentine*.—Macroscopically the rock is greenish brown and very dense. Under the microscope it is so completely altered that a spinel and magnetite are the only original minerals left. Some secondary calcite is present and also a chlorite mineral. The spinel is not as green as that described from the Cortlandtites, but has a decided brownish tinge, and is probably quite close to picotite. I am unable to tell from the rock what might have been the constituents of which it was originally composed.

The ridge formed by the norite and pyroxene-amphibole rock was followed for three-fourths of a mile and then died out. I continued on to the river hoping to find these rocks outcropping in the banks or bed, but did not find them. The river where I touched it was being channeled and jettied, and the blasting had brought fresh rock from the river bed to the surface. A couple of specimens, 32 and 38, were taken.

Sp. 32. *Biotite Hornblende Gneiss.*—This is a medium grained gray well laminated rock. The micaceous bands give it its marked gneissoid structure. It is composed of common green hornblende, which predominates, brown biotite, pleochroic from an almost opaque chocolate brown to pale yellow, plagioclase, doubtfully orthoclase, quartz, sphene, pleochroic from yellow to pink, apatite, zoisite, and magnetite. Calcite is present in grains and has not the appearance of an infiltration or secondary product. All of the above minerals show their common characters. Undulatory extinction and bent twinning lamellae were common.

Sp. 33. *Diorite.*—This is a medium grained black rock with granular structure. It is composed of hornblende, biotite, plagioclase, orthoclase, quartz, spene, and magnetite. The hornblende is dark green, compact, and strongly pleochroic. It occurs in grains. Biotite forms regular plates with strong absorption from yellow for rays vibrating parallel to cleavage to chocolate brown for those perpendicular thereto. It is not present in very large quantity. Plagioclase is the prevailing white silicate. It is xenomorphic and contains numerous minute plates of rounded and oval shapes, which are transparent with a brownish color. A few rare unstriated feldspar crystals (orthoclase) were observed. Quartz is present in a few grains. Sphene is scarce. There is quite a good deal of magnetite.

Sp. 34. *Amphibolite* (*Hornblende-schist.*)—This slide was cut from a specimen which was labelled by Tuomey as having come from West Point, Ga. It was found in the University collection at Tuscaloosa. It is a coarse grained schistose rock. The microscope shows no constituents but a very fresh compact common g reen hornblende in large prismatic crystals.

Conclusions.—In the preceding pages I have described a series of rocks consisting of sedimentary and igneous

rocks and also certain schistose crystalline rocks whose origin is unknown, and which are usually included under the general name crystalline schists.

Sedimentaries:

Spec. 9, Quartz schist.
" 14 " "

Eruptives:

Spec. 2, Biotite granite.
" 3, " " (gneissoid.)
" 4, " " "
" 5, Leucite tephrite.
" 6, Biotite granite.
" 8, Diabase.
" 10, 11, 12, 13, Biotite gneiss (metamorphosed granite.)
" 15, Diorite.
" 17, 18, 19, Hornblende Olivine Rock (Cortlandtite.)
" 21, Diorite.
" 22, Diorite.
" 23, Hornblende Olivine Rock (Cortlandtite.)
" 24, Diorite.
" 25, Diorite.
" 26 and 27, Alteration products of Diorite.
" 29, Augite Norite.
" 30, Hornblende Pyroxene Rock.
" 31, Serpentine.
" 33, Diorite.

Crystalline Schists.

Spec. 16, Amphibolite.
" 20, "
" 32, Biotite gneiss.
" 34, Amphibolite.

Of these the sedimentaries are comparatively unimportant, their relations not having been observed.

The igneous rocks are the most numerously represented,

and are by far the most interesting. Individually Sp. 18 is worthy of notice on account of the alteration of the green spinel, pleonaste, this being, as far as I can learn, the first rock in which such an alteration has been observed. In this connection attention may be called to the fact that the iron ore and emery segregation veins of the Cortlandt series,* which contain large amounts of pleonaste according to Williams,† occur in rocks related to this.

A spinel occurring with corundum in association with serpentine rocks has been reported from Dudleyville, Ala., a locality not very far distant from the point where the Cortlandtite is found. May not this be an occurrence similar to the iron ore, emery and spinel association from the "Cortlandt Series?"

Sp. 29, as an excellent type of augite norite, and Sp. 15, in which the micropegmatitic intergrowth of epidote and feldspar is to be seen, are also interesting. Sp. 10, 11, 12, 13 are remarkably fine examples of a dynamo-metamorphosed rock.

The general assemblage of eruptive rocks bears a striking resemblance to certain types described from the Cortlandt area of Westchester county, N. Y., and from Baltimore, Md., by Williams,‡ from Delaware by Chester,§ and from Ilchester, Md., by Hobbs‖.

They are also closely related to the peridotites de-

*Dana, Am. J. Sci. XX, 1880, pp. 199-200.

†Norites of the "Cortlandt series." Am. J. Sci. 33, 1887, p. 194. Uber Pleonaste and Hercynite. N. Jahrb. II, 1887, p. 263.

‡Cortland Series. Am. Journ. Sci. iii, vol. 31, 1886, pp. 26-41; vol. 33, 1887, pp. 135-200: vol. 35, 1888, pp. 438-448.

§Gabbros and Associated Rocks in Delaware. Bull. 28, U. S. G. S., 1890.

‖Some Metamorphosed Eruptives in the Crystalline Rocks of Maryland. Trans. Wis. Acad. Sci., Arts & Letters, vol. 8, 1890, pp.

scribed from North Carolina by Julien,* Wadsworth,† and Williams,‡ and from Kentucky by Diller.§ The distribution of such rocks is thus shown from the extreme south-east extension of the Appalachian system in Alabama almost throughout its entire length. It is highly probable that further researches in the region from which the above specimens were gathered will disclose another such beautiful case of magmatic differentiation as was described from the Cortlandt series by Williams,‖ and of metamorphism of the gabbros and diorites as illustrated in the papers of Williams, Chester and Hobbs, above referred to.

I have left with the igneous rocks a few specimens, 4, 6, 7, 10, 11, 12 and 13, whose schistose condition alone would cause them to be placed in the succeeding category of crystalline schists, but which after microscopical study seemed to me to be of eruptive origin. It would perhaps have been well to have placed Sp. 15, 21, 22, 24, 25 and 33 under the crystalline schists as plagioclase amphibolites. They, however, bear such a striking resemblance to similar rocks, which after a careful and very detailed study of their field relations, have been proved to be diorites, that I have retained them among the eruptive rocks.

The crystalline schists include those which are markedly schistose and whose origin is entirely unknown. They were found associated with and cut by the igneous rocks. Future studies may show them to be metamorphosed phases of some of the eruptives.

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*Proc. Boston Soc. Nat. Hist., vol.

†Olivine Rocks of North Carolina. Science, vol. 3, No. 63, 1884, p. 486.

‡The Non-feldspathic Intrusive Rocks of Maryland and the Course of their Alteration. Am. Geol., vol. 6, 1890, p. 44.

§Peridotite from Elliot county, Ky. Am. Journ. Sci., iii, vol. 31. 1886, p. 121: Bull. U. S. G. S., No. 38, 1887.

‖l. c.

Taking the rocks as a whole, disregarding the quartz-schist, their general characters are those of that great mass of rocks which lies below all beds of undoubted sedimentary origin, and which are known as the Archaean rocks.

Supplementary Notes of Dr. Clements.

In the summer of 1894, I collected from the vicinity of Gold Hill, in Lee county, and from a railroad cut near Dadeville, specimens of eruptive rocks which were submitted to Dr. Clements for examination. His report is as follows:

"No. 1. (35) From near Gold Hill, Lee county. This is a very fresh specimen of a typical *Olivine-diabase.* Fine grained. The mineral constituents given in order of age are, apatite, triclinic feldspar (anorthite), olivine, magnetite, augite. Feldspar and augite predominate, then comes magnetite with very little olivine and apatite. The triclinic feldspar is *anorthite* and occurs in long lath-shaped individuals showing polysynthetic twinning. It is for the most part quite fresh. Beginning decomposition makes the plates appear somewhat dull. In a more advanced state these dull spots are seen to be made up of minute grains of epidote. The *augite* is in very light brownish grains and wedge-shaped pieces which lie between the feldspar individuals, as a cement, and from them have received their outlines. The characteristic cleavage angle is well marked. Augite is very fresh. *Magnetite* appears in irregular individuals with only one or two crystal faces developed, the rest of its contours being determined by the feldspar crystals touching it. *Olivine* is present in only one large crystal. It is partially altered, serpentine forming around the edges and along the cleavage lines. A few obscure greenish spots in the ground mass may be completely altered olivines. *Apatite* is scarce, occurring in long needles penetrating the other minerals. The structure of the rock is typical ophitic.

No 2 (36). From railroad cut near Dadeville. *Hy-*

persthene-gabbro with a great deal of hornblende and biotite; might be called a *hypersthene-hornblende-biotite gabbro*. Coarse grained, granitic structure.

Hypersthene, the most characteristic mineral, occurs in rounded crystals surrounded by a border of compact green hornblende. Between the hypersthene and hornblende there is frequently a zone which is made up of the hornblende intergrown with a white mineral of very low angle and double refraction, probably feldspar. Hypersthene is pleochroic, from pink to light greenish tinge. The characteristic brown inclusions are present. It is very fresh, only in places along cleavage lines are there traces of beginning decomposition. *Diallage* is present in comparatively small quantity and is surrounded by the strong pleochroic green hornblende just as the hypersthene is. *Hornblende* occurs in a few large plates in the section, but for the most part as a border, varying very much in width around the pyroxene crystals. It is very pleochroic, the color changing from light yellow to bluish green and dark olive green. It contains numbers of dark interpositions, different from those in the hypersthene, in the form of rounded plates and long needles. Some of the apparent needles are undoubtedly only the plates on edge. For the most part they are perfectly opaque, but some permit a little light to pass through and are of a dark chocolate brown. The characteristic hornblende cleavage is frequently seen. It includes plates of biotite and large crystals of apatite and magnetite. *Biotite* appears in plates with its customary strong pleochroism, straw yellow to chocolate brown, and perfect cleavage. It is included both in the pyroxene and hornblende. *Feldspar* forms the mass of the rock and appears in polysynthetically twinned grains. It is the basic *anorthite*, and is perfectly fresh and clear. *Magnetite* is in rounded grains and is included in the

other minerals. *Apatite* occurs quite abundantly and in large crystals which have more or less rounded outlines. Feldspar, hypersthene and hornblende make up the mass of the rock, then diallage, biotite, magnetite and apatite. The structure is granitic, and the specimen is remarkably fresh.

No. 3 (37). *Hypersthene-hornblende-biotite-gabbro.*—Same locality as the preceding. What is said of No. 2 holds good for No. 3, except that the latter contains rather more diallage in proportion to the other constituents and also more biotite and apatite. In a few places the feldspars show signs of deformation in bent twinning lamellæ. This is, however, apparently only local, as it is seen only where decomposition has begun, and may be due to the hydration of the feldspar exerting pressure on the surrounding crystals."

In the following notes by Dr. Clements, Nos. 38, 39, 40 and 42, descrie the chief varieties of the green schists of the Hillabee type. Nos. 41 and 43 are probably altered sedimentary rocks; the latter is of some interest for the reason that in it through Clay county and parts of Coosa many years ago great numbers of pits have been sunk in the search for copper. The graphite seems to have been the attraction, and the prime cause of the search. I am not aware that copper has been anywhere found in it. No. 41 is a sample of the graphitic schist which extend through Coosa county parallel with the course of Hatchet creek and at no great distance therefrom:

(38) 1. Actinolite-epidote-schist. From McGhee's, Clay Co.

This a very fine grained compact grayish green schist, composed of epidote, in grains, lying in a fine felt of actinolite needles, with here and there a lenticular area of quartz. Nothing in it gives an indication of the origin of the rock.

(39) 2. Sericite-schist. From McGhee's, Clay Co.

This is macroscopically a light dirty yellow, schistose rock, with silky luster upon the faces parallel to the schistosity, and showing on traverse fracture a well marked "augen" structure on a small scale, a dark mineral forming the center of the eyes. Under the microscope the rock is seen to be composed of thin alternating bands of two kinds, one of which is composed essentially of cataclastic quartz, with a small amount of unstriated feldspar, the other of sericite, scattered actinolite needles, and a large quantity of small epidote grains. These sericitic bands show a very noticeable wavy structure, and extend across the thin section in undulatory lines, separating here and there to wrap around the hornblende which forms the eyes. Upon examination these eyes are seen to be made up of a number of fragments of a very dark green hornblende. The fragments in most, if not all, cases belong together, showing from the manner in which they are separated the crushing which the rock has suffered. The hornblende is compact in the center and cloudy with minute dark specks, but on the edges it is light colored, frayed out as it were, and passes over into aggregates of actinolite and epodite lying in quartz cement. As we go away from these eyes the quartz diminishes in quantity, and the actinolite also. Sericite begins to increase, and we pass over into the bands consisting of sericite and epidote, with a few needles of actinolite, and so dense that the quartz can not be distinguished. The quartz bands have scat-

tered actinolite needles and epidote grains in them here and there, and also a few flakes of sericite. The crushed character of the hornblende and quartz is sufficient evidence of the dynamo-metamorphic action to which the rock has been exposed, but no satisfactory proof of its original condition could be found. My belief is that it was not derived from a clastic, unless it was itself metamorphosed, but was derived from some eruptive rock.

(40) 3. Actinolite-epidote-zoisite-schist. Chandler's Spring.

This is a quite rotten, fine grained gray rock macroscopically. Besides the actinolite, epidote, and zoisite, it contains a small quantity of granular quartz, and is badly discolored by brownish iron hydroxide. It bears now no evidence of clastic origin, but it would really be impossible to say from what it was derived, whether from an eruptive or a sedimentary.

(41) 4. Graphite-schist. Ingraham's Mill. Clay Co.

This appears very much like the phyllites, exceedingly fine grained and fissile. It consists of a fine grained granular aggregate of quartz and feldspar, with rounded zircon crystals and fragments of tourmaline and flakes of sericite. The rock is rendered quite dark by innumerable minute needles of rutile and a black substance which is scattered all through it, occuring in specks without any determinable form. This substance has a black metallic luster in incident light, disappears when the rock is heated to a high temperature, and was determined to be graphite. Part of the rock is discolored by brown iron hydroxide derived from the alteration of ferruginous carbonate, which occurs in well developed rims in parts of the rock. If, like many others, you consider the presence of graphite as sufficient evidence of the existence of living organisms from which it was derived, then the original sedimentary character of the rock is proven, although now it is so metamorphosed

that it contains no indications (other than the presence of graphite) of its origin.

(42) 5. Actinolite-schist. Lecroix, (Millerville,) Clay county.

Fine grained green schist, seen under the microscope to be composed of actinolite, epidote, flakes of chloritic material, and sphene, in a clear granular groundmass of clear unstriated feldspar and some quartz. The granular aggregate is rendered schistose by the parallelism of the actinolite needles and chlorite flakes. It is impossible to determine the original character of the rock.

(43) 6. Graphitic muscovite-schist. J. W. House. Clay Co.

Macroscopically the rock is a medium grained grayish-blue schist, showing large light greenish clumps of muscovite. Under the microscope it is found to be composed of quartz, muscovite, and graphite, with spots of white opaque leucoxene-like substance. Cataclastic structure is very plainly shown by the quartz. If the graphite is here, as in No. 4, to be considered sufficient evidence of life, it is probable that the rock is of sedimentary origin, though it exhibits now no sedimentary character.

(44) 7. Mica-schist (shistose eruptive rock). Darsey No. 4. Coosa Co. A dark bluish-black fine grained more or less schistose rock. Under the microscope we find a few eyes of grayish and altered triclinic feldspar, which lie in a fine grained cataclastic groundmass composed of quartz and feldspar mosaic—in which the quartz predominates—with flakes of brown mica and some chlorite. There are also found large quantities of sericite, with a considerable quantity of fairly large crystals of epidote, and rare ones of reddish sphene. The mica and epidote are present in large quantities, and almost obscure the clear white elements of the groundmass. The rock is clearly at present in a very badly mashed condition, and was probably derived from

an acid, granitic eruptive.

(45) 8. Amphibolite or hornblende schist. Darsey No. 5. Coosa Co. Dark green schistose rock made up of strongly pleochroic, common green hornblede in small partly automorphic crystals, together with a large quantity of magnetite and considerable epidote, in a granular groundmass of unstriated feldspar, with some quartz. The hornblende is beginning to get fibrous along the cracks which traverse the crystal perpendicular to prismatic cleavage. The rock is now a crystalline schist, of which nothing more can be said than that it was probably derived from some such basic eruptive as probably a gabbro.

3. PRELIMINARY PETROGRAPHIC NOTES ON SOME METAMORPHIC ROCKS FROM EASTERN ALABAMA,

BY

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The following notes are the results of a brief examination of some twenty specimens which were submitted to me by Dr. Smith. No attempt has been made to go into minute mineralogical details, the determination of which will require further study. The naming of the rocks is only tentative, until further petrographic investigation and chemical analyses shall determine their true classification.

The metamorphic rocks of Alabama and Georgia may be differentiated into two series. The older, or crystalline series, includes crystalline schists and gneisses, whose origin is doubtful, together with large masses of gneissoid granite. The younger, or clastic series, is typically made up of phyllites, sericite schists, chlorite schists, conglomerates, usually containing much feldspar, quartzites, crystalline sandstones, and, in a portion of the region, limestones and marbles. In many cases this younger clastic series has been so metamorphosed that it is difficult to distinguish its members from the older crystalline complex. The rocks of both series are closely associated with rocks of undoubted igneous origin.

In some portions of the area there are broad belts in which the country rock is largely igneous. Such a zone of igneous rocks, which are chiefly basic, extends through the northern portion of Cobb County, through the central portion of Paulding into Carroll County, Georgia.* Another area of igneous rocks, which are also chiefly basic, has been mapped by Mr. Hayes in the southern portion of Cleburne County, Alabama.† The granites associated with the crystalline schists of the basal complex have already been mentioned.

The major portion of the igneous rocks of the two series are intrusive, but it is probable that further investigation will prove that some of the metamorphic schists of the region are altered effusive rocks.‡ Most of the igneous rocks seem to have been intruded previous to the deformation of the associated rocks, for, as a rule, they give evidence of having suffered extreme dynamic metamorphism.

CLASTIC ROCKS.

Among the twenty specimens submitted to me, only one rock (No. 2) showed any evidence of clastic origin.

No. 2. (101a and 101b) Locality: Blake Mountain, 3 to 4 miles south of Arbacoochee, Cleburne County, Alabama.

Siliceous-magnetite schist. Megascopically this is a fine-grained siliceous rock of dark blue color. It is irregularly banded by alternating layers of magnetite and vitreous quartz. Small crystals of garnet form "knot-

*Unpublished Tallapoosa and Cartersville folios.

†See also Geological Map of Alabama, published in 1884, where the area is also shown. E. A. S.

‡A microscopic examination of a specimen from Owl Creek, 2 miles south of Lovingood's Bridge, Cherokee County, Ga., shows it to be on acid effusive rock. Prof. Williams described a porphyry from the "Archæan Area of Georgia near Tennessee" in American Journal of Science. Vol. 7, No. 6, p. 57, July, 1893.

en" on the cleavage surface of the schist. A rough separation of the magnetite and quartz, gave about equal volumes of each.

A microscopic examination confirms the above, and proves that quartz and magnetite are the essential minerals of the rock. The quartz occurs as a fine mosaic of interlocking grains. Much of it is presumably of clastic origin. Some of the quartz has, what is apparently, an inner clastic grain, which has been enlarged by a secondary deposition of quartz, oriented in optical continuity with the original grain. Secondary quartz also occurs as interstitial deposits between the original grains. Magnetite occurs sparingly as octahedral crystals, but usually as irregular masses and very fine grains. Magnetite is in many cases included in the secondary quartz as fine grains. Some of the magnetite is surrounded by a zone of leucoxene, which suggests that it is probably titaniferous. No garnets were observed in the thin sections.

This rock is part of a metamorphic zone which has been mapped by Dr. C. Willard Hayes, U. S. Geological Survey, as crossing the southeast corner of the Anniston sheet near Micaville. *This zone consists of garnetiferous, siliceous, and kyanite schists, and is probably a part of the younger clastic series.† The metamorphism may be regional but the proximity of large intrusive masses of diorite rocks, suggests a local cause.

GNEISSES.

Under this heading I have grouped the rocks which

*I am indebted to Mr. Hayes, of the U. S. Geological Survey, for the use of his notes on the unpublished Anniston and Tallapoosa folios, and for much general information in regard to this region.

†The Geological Map of the State, published in 1894, shows with approximate accuracy, the position of this zone which is part of the Talladega slate series. E. A. S.

have no very close affinities but all show a gneissoid structure.

No. 1. (100a and 100b) Locality: Country rock from Arbacoochee, Cleburne County, Alabama. *Biotite-chlorite gneiss.* Megascopically, the hand specimen shows this to be a grey-green colored rock, having a rather indistinct foliation. The foliation is produced by seams of dark green minerals which are mostly chlorite and biotite. Quartz and feldspar occur in irregular masses, which are somewhat elongated, and roughly parallel.

The microscope discloses a rock made up of feldspar (plagioclase?) largely replaced by secondary minerals: quartz, much of which is secondary; biotite partly altered to chlorite; a few scattered grains of augite: epidote, and a little muscovite.

Where the outline of the feldspars can still be traced they appear as tabular idiomorphic crystals. Much of the feldspathic material is replaced by quartz, as mosaics of interlocking grains, or by epidote and zoisite. Faint traces of either lamellar twinning or Karlsbad twinning can usually be observed in the altered feldspar. Under crossed nicols the outline of the original feldspar is often entirely lost, for there is a gradual merging into the groundmass. In some cases a zone of clear fresh-looking feldspathic material surrounds the altered feldspar phenocryst. This outer rim, which must be a secondary enlargement, shows no twinning and is probably albite. The original rock seems to have contained plagioclase and orthoclase in about equal proportions.

Quartz occurs as irregular mosaic patches of interlocking grains, which are probably recrystallizations of the silica of single quartz individuals, or replacements of feldspars.

The groundmass consists of allotriomorphic grains of quartz interwoven by irregular stringers of biotite and

chlorite. Biotite and chlorite also occur in larger masses, which are always elongated and have a rough parallelism, thus giving the rock its foliated structure. Epidote occurs in the groundmass, and also as a secondary mineral after plagioclase, in small prisms. The zoisite, secondary after plagioclase, occurs as very fine grains and granular aggregates. This rock probably belongs with the gneisses of the basal complex, although the typical gneiss differs from this in having a granular instead of a porphyritic structure.

No. 14b. (114a and 114b) Locality: 1 mile north of West Point, Georgia, in Chambers County, Alabama.

Biotite-gneiss: Megascopically, this is a gray and white banded rock; the dark bands consisting of biotite and a ferro-magnesian silicate, and the light bands, of white feldspar and glassy quartz.

A microscopic examination shows the rock to consist essentially of quartz, biotite, feldspar, and hornblende. It has an orignal granular structure, with a secondary foliated structure.The segregation of the basic minerals into parallel zones gives it the banded appearance.

The quartz and feldspar occur in allotriomorphic grains, and individuals. Except some of the fine quartz grains, which are probably secondary, both quartz and feldspar are cataclastic. All of the feldspar shows polysynthetic twinning.

Biotite and green hornblende are present in about equal proportions and are closely associated. Biotite occurs in irregular shreds and plates, and the hornblende in deformed prismatic crystals. As an accessory constituent there are present a few grains of augite, and considerable brown tourmaline in small grains. A little chlorite is found in the rock as a secondary mineral after biotite.

The locality of this specimen is so isolated that a lithologic correlation can be of little valne. It bears a

close resemblance, however, to the specimens of gneiss which were collected from the basal complex of Cleburne County, Alabama, and Carroll, Cobb, and Cherokee Counties, Georgia. The rock in question (14b) differs from the other gneisses in respect to the predominating ferro-magnesian silicate. In this specimen from Chambers County (14b), hornblende is very plentiful, while augite is only an accessory mineral. In the other gneisses, from the region farther north, augite predominates very largely over hornblende.

Nos. 15 and 16. (115a, 115b, 116a, 116b.) Locality: Wright's Mill, near Auburn, Lee County, Alabama.

Augen Gneiss.—Megascopically the rock consists of a dark groundmass of mica, filled with augen of quartz and feldspar. The augen are either lenticular, or drawn out to thin seams. They vary from two inches to microscopic in diameter.

Microscopic examination shows that this rock contains quartz and feldspar, as minerals forming the augen, and biotite, chlorite, and epidote in the groundmass.

The quartz, where it is not completely granulated, gives wavy extinction, except in a few cases, in which it seems to be secondary. The feldspar is for the most part plagioclase, but a few large phenocrysts of orthoclase, showing Karlsbad twinning, were also observed. Structurally the augen are of two kinds. First, those formed of single mineral individuals; and second, those formed of an aggregation of minerals. The extreme mechanical deformation that this rock has undergone, is well shown by the granulations and alterations to which the augen have been subjected. In many cases the phenocrysts of feldspar or quartz, have been granulated on opposite sides, corresponding to the direction of the schistosity, and the material thus formed has been drawn out into a lenticular-shaped mass, with the solid portion of the

minerals as a nucleus. In other cases the original phenocryst has been entirely granulated, and the material thus formed has been drawn out into a lenticular-shaped mass, or sometimes even into a mere thread.

In many cases the augen are not phenocryst, but are probably parts of the original rock, which have been separated by the lines of shearing, now marked by the groundmass of biotite and chlorite. These composite augen have the same lenticular shape and granulated boundaries as the simple augen. The composite augen have a holocrystalline structure and are composed chiefly of plagioclase feldspar, with some orthoclase and quartz, and a little biotite and epidote. It is possible that they are not fragments of the original rock, but are the results of the recrystallization of the feldpathic material, of single phenocrysts.

The groundmass of the rock consists chiefly of biotite, which has been greatly squeezed, and bent to conform to the countour of the augen. A little chlorite is associated with the biotite. Grains of epidote are scattered throughout the groundmass. Small lenticular grains of quartz are also found in the groundmass.

As in the case of the last described specimen, the locality of this rock is too remote from that at which any other material was collected, to make a lithologic comparison of any interest. Before its mechanical deformation it seems to have been a basic or intermediate porphyritic rock. The present dark silicates of the rock are probably all secondary, and afford little information as to its original mineralogical composition.*

IGNEOUS ROCKS.

The rocks of the metamorphic area of Alabama, and

*See also Dr. Clements' description of the same rock. E. A. S.

the adjacent portions of Georgia, have been exposed to the disintegrating atmospheric agencies during two periods of base leveling, and are therefore deeply weathered. The petrographical investigation of these rocks is attended with difficulties, for it is seldom that specimens can be secured from below this zone of weathering.

Nearly all the rocks examined by me from this region, contained an abnormally high percentage of quartz. In many cases a part of the quartz is plainly secondary, being deposited subsequent to the deformation of the rock; while in other cases, the existence of two generations of quartz seemed probable, though positive evidence was wanting. The source of the silica of the secondary quartz can usually be traced to the breaking down of the silicates of the feldspars, but in some instances it seems to have been derived from infiltrating solutions. In the basic rocks, secondary quartz is frequently accompanied by calcite. The kaolinization of the feldspars and chloritization of the dark silicates are among the most frequent observed phenomena, accompanying the weathering of these rocks.

Besides these superficial alterations, many of the igneous rocks of the region have been subjected to the metasomatic and paramorphic changes which accompanied the mechanical deformation of the province. A rock which has suffered these various phases of metamorphism is frequently entirely altered, both as to chemical composition, and physical structure. The determination and classification of the igneous rocks of the region, is therefore, a difficult problem.

ACID ROCKS.

Granite is the prevailing type of acid rock, and in fact the only one which has thus far been definitely deter-

mined. Some rocks which have been classed as granites may prove to be syenites, their quartz being secondary. There are also, in the region, some aplite dikes which are apophyses from larger granite masses.

The granites have two distinct phases, between which, however, there are intermediate types.

The more acid granite is made up of quartz, orthoclase, microcline, muscovite, and biotite, with very little lime soda feldspar, together with accessory minerals. The more basic type is an aggregate of quartz, orthoclase, microcline, with considerable plagioclase, and biotite, hornblende, together with accessory minerals.*

Of the twenty specimens sent by Dr. Smith, fifteen were classed as igneous or altered igneous rocks, and of these only one is an acid rock.

No. 17. (117a and 117b). Locality: 3 miles west of Loachapoka, Lee County, Alabama.

Granite.—This rock shows a typical granite structure. Pink feldspar, glassy quartz, and biotite can be distinguished megascopically.

Microscopically, the rock has granular structure and the mineral constituents are all allotriomorphic. The feldspars are chiefly potash-feldspars, both orthoclase and and microcline being present. The orthoclase shows no twinning, while the microcline shows the double twinning, giving the characteristic cross hatched structure. A multiple twinning feldspar which is present in limited quantities is probably albite. The feldspars when not too much decomposed show more or less cataclastic structure.

The quartz of the granite, which occurs in irregular masses, is much fractured and gives wavy extinctions.

*The rock from Stone Mountain, Georgia, is an example of this granite. The occurrence described by C. W. Purington, in The American Geologist, Vol. XIV, p. 105. August, 1894.

Biotite is uniformly distributed through the rock, as small scales and plates. Magnetite occurs sparingly as accessory mineral. Muscovite and kaolin are present as decomposition products of the feldspars.

This granite belongs to the more acid type described above. Mineralogically this granite is quite similar to one collected by Mr. Hayes near Mount Zion, Carroll County, Georgia. The Mt. Zion granite has, however, been subjected to mechanical deformation, which has given it a secondary parallel structure.

BASIC ROCKS.

The greater part of the basic rocks of the region can be embraced under the field terms, "greenstones," and "greenstone schists." These rocks are even more liable to alteration by atmospheric agencies than the acid rocks, and are correspondingly difficult to determine. In the collections made by Mr. Hayes and myself, there are examples of diorites, gabbros, diabases, pyroxenites, together with many hornblende, chlorite, and epidote schists whose antecedents are more or less doubtful. This collection includes no olivine bearing rocks, but Dr. Smith* has described an olivine rock from near Notasulga, Alabama.†

The talc (soapstone) slates which are not uncommon in this metamorphic area, are probably alteration products of very basic rocks, but as far as I know they have

*Outline of the Geology of Alabama.

†This is the Ossipyte described by Prof. Hawes, No. 22 of his list. Other olivine-bearing rocks see the notes of Dr. Clements on specimens No. 17, 18, 19, and 23, and also on the specimen from near Gold Hill, in Lee county, No. 35. E. A. S.

received no petrographical study. The rocks associated with the corundum deposits are also of very basic nature.*

The basic rocks of Alabama have been described by Dr. Smith and his assistants as hornblendic gneiss, hornblende schist, diorite, talcose slate, steatite and chloritic schists, in the various publications of the Survey. In Georgia* McCallie and King have classed the basic rocks as hornblende gneisses, hornblende rocks, periodotites, etc.

*See Bulletins 1 and 2, Geological Survey of Georgia.

Like the acid rocks, the basic rocks are characterized by a high percentage of quartz, most of which is plainly secondary. In at least one instance an isotropic substance was observed which resembled opal.† The other secondary minerals observed are calcite often present in large quantities, hornblende and uralite, albite (?) (No. 5), epidote, zoisite, chlorite, leucoxene, garnet, and spene. Two examples of saussurite gabbro have been recognized‡.

It is evident that the above list includes both the secondary minerals which are the result of dynamic metamorphism, and those which owe their existence to atmospheric action, or weathering.

Regarding the occurrence of the basic rocks, as far as our present knowledge goes, they are all intrusive. They occur as dikes, and larger intrusive masses, in both the older and younger series. the larger masses, however, seem to be confined to the basal crystalline series. As these basic rocks show wide differences in their relative amount of metamorphism, it is probable that there was more than one period of intrusion. As

*Preliminary Report on the Corundum Deposits of Georgia, by Francis P. King, Geological Survey of Georgia, Bulletin No. 2, pages 71-4, 80.

†No. D 6. Chestnut Gap P. O., Gilmer Co., Ga.

‡Nos. D 7 and D 11, from near Allatoona, Bartow Co., Ga.

yet the relative ages of the different types of basic rocks, have not been determined. In general the basic rocks occur in broad belts which have considerable extension along the strike. Such a belt has been mapped by Mr. Hayes and his assistants extending through Cobb, Paulding, into Carroll counties, Georgia, and judging from specimens sent me by Dr. Smith, it extends into Randolph county, Alabama.

Until more material has been collected, with the end in view of tracing one phase of a rock into another (for example from massive to schistose) the classification of these basic rocks must be more or less arbitrary. For convenience of description I have divided them into schistose and massive rocks. The term schist is used in a relative sense only, for as a matter of fact nearly all these basic rocks have a more or less well marked cleavage.

Diorites.

Diorites are the most common basic rocks of this region. They occur as dikes in the younger series, and as dikes and larger intrusive masses in the basal crystalline series. There are two main types:* The quartz diorites in which quartz is a prominent mineral, and the ordinary diorites, in which it plays only a secondary part. We are here again confronted with the difficulty of determining which is primary, and which is secondary quartz, but it seems probable that the quartz diorite type predominates in the region. Dr. Smith sent me one each of these two types.

It should be noted that in these altered rocks it is not always possible to determine whether a rock should be classed as a diorite, or as an epidiorite. The alteration of augite to compact hornblende and uralite is a common

*It should be noted that no chemical analyses have been made of these rocks, and the percentage of silica may prove to be so high that they can not be classified as basic rocks.

paramorphic change, and with limited amount of material, it is often not feasible to determine whether the amphibole be primary or secondary. As a temporary expedient, therefore, I have classified the rocks showing little or no ophitic structure, and in which the feldspar is an acid labradorite, as diorites, unless the amphibole is plainly secondary after augite. The rocks which had a marked ophitic structure, and whose feldspar was the more basic labradorite, I have classed as diabases, or epidiorites as the case may be.

No. 14a. (113a and 113b) Locality seven or eight miles north of Columbus, Georgia, in Lee county, Alabama.

Diorite.—Megascopically a green and white speckled, medium grained rock, in which hornblende, feldspar and quartz can be distinguished.

Microscopic examination shows this to be an even grained holocrystalline rock, whose original structure has been more or less defaced by a secondary parallel structure. It is made up of green hornblende, plagioclase, quartz, a little augite, and epidote and calcite, as secondary products. Some of the plagioclase occurs in tabular crystals, and these together with the hornblende suggest an ophitic structure.

The plagioclase is well twinned and the lamellae give a maximum extinction of about 30 deg., indicating labradorite. The augite is associated with hornblende. The quartz occurs in small, clear, lenticular grains. A few irregular patches of epidote and calcite were observed in the slide.

No. 18. (118a, 118b and 118c) Locality, Ragan's Old Mill, Lee county, Alabama.

Quartz-diorite.—This is a dark green, schistose rock, in which hornblende and feldspar can be distinguished megascopically.

Microscopically the chief constituents are seen to be green hornblende, plagioclase and quartz. The rock is holo-crystalline, and has a secondary parallel structure. Hornblende is the predominating mineral and it occurs in elongated allotriomorphic masses. The feldspar is the oldest constituent and it has a tendency to assume lath-shaped crystals. It is well twinned and the lamellae extinguish at about 30 deg. as a maximum, indicating a labradorite. The twinning according to albite law is frequently accompanied by both Karlsbad and pericline twinning.

Quartz occurs in irregular patches, much fractured and giving wavy extinction, and is probably a primary constituent of the rock. It is also present in larger masses, showing no cataclastic structures, and this is evidently a secondary constituent of the rock.

Hornblende Schists.

This embraces a series of schistose rocks, consisting chiefly of quartz and hornblende, with often some plagioclase, and usually some augite. They are probably alteration phases of diorites and quartz diorites.

No. 7. (106a and 106b) McDiarmid Old Place, near Brownsville, Clay county, Alabama.

Hornblende-schist.—Megascopically this rock is of dark green color. Crystals of green hornblende occur in an aphanitic ground mass.

Microscopic examination shows that the essential minerals of this rock are green hornblende, quartz, muscovite, and epidote. The hornblende occurs in irregularly bounded masses, scattered through a groundmass, consisting of quartz, muscovite and epidote.

The groundmass consists of lenticular quartz grains interwoven by shreds of muscovite. Epidote occurs as scattered grains and granular masses. Calcite occurs

sparingly in small masses. It is interesting to note the presence of muscovite which was not observed in any other of these schists.

No. 10 (109a and 109b). Locality, two miles west of Idaho, Clay county, Ala.

Hornblende-schist.—Megascopically, this is a fine grained dark green rock. Prismatic crystals of hornblende can be distinguished, and smaller grains of quartz and feldspar.

Microscopic. A rock made up of pale green hornblende, augite, plagioclase and quartz. The hornblende occurs in elongated masses arranged parallel. Augite is associated with the hornblende. Plagioclase is not very plentiful, and occurs as tabular crystals. The feldspar shows multiple twinning, but the determination of it is unsatisfactory. Epidote is scattered through the rock in small grains. Quartz occurs in lenticular grains and seems to be entirely secondary.

No. 19 (119a and 119b). Locality, one mile south of Double Bridges Ferry, Elmore county, Ala.

Hornblende-schist.—Megascopically, this rock is of a dark green color, and has almost a slaty cleavage. When broken across the cleavage it is seen to be a finely banded crystalline schist. Dark bands of prismatic crystals of hornblende and chlorite alternate with light bands, composed chiefly of fine grains of quartz.

Microscopic. The thin section discloses green hornblende quartz and a little augite to be present. The hornblende occurs in prismatic crystals which have a rough parallelism and are partially altered to chlorite. The quartz occurs as irregular, interlocking grains. A few grains of augite were observed scattered through the section. Considerable magnetite is present in irregular shaped masses, and octahedral crystals.

Diabases.

Under this heading I have grouped diabases, quartz diabase, epidorite, and some schists which are plainly mechanically deformed phases of these rocks. The quartz diabase seems to predominate in the region, but we are here again involved in the difficulty of distinguishing between the primary and secondary quartz.

No. 13. (112a and 112b) Locality, two miles southeast of Fredonia, Chambers county, Ala.

Epidiorite.—Megascopically, this is a medium coarse grained rock, made up of dark green hornblende, white feldspar and quartz.

Examination of thin section shows the rock to be made up of hornblende, augite, plagioclase, quartz and epidote. The minerals are all arranged more or less parallel, and the original structure of the rock has been defaced. Except the plagioclase, which shows a tendency to crystallize in tabular form, the minerals are all allotriomorphic.

The hornblende is of a pale green color, and is plainly derived from the augite. The transition from augite to hornblende can be observed in the thin section.

The plagioclase, which is not very plentiful, shows albite twinning, but the determination is unsatisfactory. Quartz occurs as an alteration product in small irregular grains.

Epidote is the most plentiful mineral. It seems to be an alteration product of both the feldspar and the ferromagnesian silicates.

No. 11. (110a and 110b) Locality, near Louina, Randolph county, Ala.

Diabase-schist.—Megascopically a finely banded rock. Dark bands of green hornblende alternate with light colored bands of pink feldspar.

Microscopic examination shows this rock to be made up of pale green hornblende, plagioclase, with a little quartz and augite. The original structure of the rock has been entirely destroyed by the mechanical deformation. The hornblende occurs in irregular elongated masses, having a rough parallelism. The augite is closely associated with hornblende.

The plagioclase occurs in patches of mosaic intergrowths, which are probably formed by secondary recrystallization of the feldspar. With it is associated a little quartz. The albite twinning is rather inconspicuous, and the determination of the feldspar unsatisfactory, but it probably belongs near the basic end of the lime-soda-feldspar series. Epidote is scattered through the rock in small grains.

No. 12. (111a and 111b) Locality, one and one-fourth miles north of Fredonia, Chambers county, Alabama.

Quartz-diabase.—Megascopically this is a dark green holocrystalline rock. Dark green hornblende, white feldspar and glassy quartz can be distinguished in hand specimens.

A microscopic examination reveals a rock with partially defaced ophitic structure, consisting of hornblende, plagioclase and quartz. The rock has a parallel structure induced by the mechanical deformation. The plagioclase exhibits a tendency to form tabular crystals. The lamellæ give a maximum extinction of about 40 degrees, indicating a basic labradorite. The hornblende occurs in irregular allotriomorphic masses, which often enclose the feldspar crystals. The hornblende is dark green, and shows an extinction of about 20 deg. The hornblende is partly altered to chlorite. Quartz occurs in irregular grains, which, like the feldspar, are cataclastic. Small grains of epidote are scattered through the rock.

No. 3. (102a) Locality, Oakfuskee, Riddle's Bridge, Alabama.

Quartz-diabase-schist.—Microscopic.* Int hin section of this is seen to be a holocrystalline rock, in which a secondary foliation has been produced by mechanical deformation. It consists essentially of pale green hornblende (partially altered to chlorite), plagioclase, quartz, which is probably mostly secondary, with a little augite and zoisite.

The feldspar, which is probably anorthite, occurs in broken and partially replaced crystals, which were originally tabular. The hornblende occurs in irregular masses elongated parallel to the foliation. The original structure of rock was evidently ophitic.

Quartz occurs in small irregular patches all through the slide, often replacing in part the plagioclase crystals. Much of the quartz is fissured and gives wavy extinction. If this cataclastic quartz is secondary, it must have been formed previous to the mechanical deformation of the rock. The zoisite occurs as granules and prisms all through the rock. Epidote occurs sparingly in slide as small granular masses and scattered grains.

Pyroxenites.

The two rocks under this heading are characterized by the entire absence of feldspar and quartz. One of them is plainly a partly altered and squeezed pyroxenite. The other, which I have called an amphibolite, is made up chiefly of uralite, which is probably paramorphic after augite.

No. 9. (108a and 108b) Locality, Sec. 1, T. 24, R. 20 E., near Goodwater, Coosa county, Ala.

*Hand specimen of this rock was lost.

Pyroxene-epidote-schist.—Megascopically, this is a pale green rock, on the fresh fracture of which the glittering surfaces of crystal faces can be seen. These crystals are of a light green color, and are contained in similarly colored groundmass.

Under the microscope the rock is seen to consist of pyroxene partly altered to epidote. In the slide no definite crystalline outline can, as a rule, be made out, but it seems to have originally been an intergrowth of prismatic crystals.

No. 8. (107a and 107b) Locality, D. C. Carmichael, near Brownsville, Clay county, Ala.

Amphibolite.—Megascopically, the rock is of light green color, and much resembles the chlorite schists previously described. The examination of thin section shows it to consist essentially of a holocrystalline intergrowth of a pale green hornblende. A little augite occurs with hornblende. Some of ths hornblende has been altered to chlorite. Quartz and feldspar are entirely wanting in this rock.

Chlorite and Epidote Schists.

This group includes all the most highly altered basic rocks of the region. Megascopically they are soft greenish rocks which often have a slaty cleavage, and can easily be mistaken for clastics. The microscopic study of a series of specimens of the schists show them to be of undoubted igneous nature. They are usually found to contain some secondary quartz, and often contain remnants of a feldspathic constituent. They are probably derived from the diorites and diabases, and from the most basic rocks.

No. 4. (103a and 103b) Locality, three-fourths miles southwest of Chandler Springs, Talladega county, Alabama.

Chlorite schist.—Megascopically, this is an aphanitic rock, having a light green color and an imperfect cleavage.

Microscopic. In thin section the microscope discloses a rock made up of hornblende, chlorite and zoisite. The chlorite occurs as plates with irregular outline, and as fibrous masses. The zoisite occurs as granules and prisms. A few grains of quartz were observed in section. The hornblende is pale green, and occurs in small fibrous masses.

No. 5. (104a and 104b) Locality, one mile south of Coleta, Clay county, Alabama.

Chlorite-epidote-schist.—Megascopically, the rock is of a light green color. Rounded phenocrysts of quartz and feldspar (chiefly quartz) are seen enclosed in a groundmass of light green color.

The microscopic examination shows it to be a highly metamorphosed rock, made up almost entirely of secondary minerals. It consists essentially of quartz, epidote, chlorite and zoisite.

Tabular crystals of what were once phenocrysts of feldspar are scattered through the rock. In several of these phenocrysts a little of the polysynthetic twinning feldspar was observed, but for the most part the feldspars have been entirely replaced by mosaics of interlocking quartz grains, or by aggregations of quartz, epidote and zoisite.

The groundmass of the rock consists of an aggregation of epidote, chlorite, zoisite and quartz. The chlorite occurs in irregular stringers, and the epidote usually intergrown with zoisite. Less frequently epidote occurs as separate masses and filling cleavage cracks. The epidote and zoisite seems to be secondary after augite, for a few unaltered augite grains were included in these aggregations of secondary minerals.

The quartz occurs as mosaics with irregular boundaries, and as small veins, cutting all the other minerals. There seems to have been an infiltration of quartz after the foliation of the rock. This would make two generations of quartz. First, that formed during the metamorphism of the rock, and second, that of secondary infiltrations after the foliation of the rock. There is also the possibility that the rock contained some primary quartz. The plagioclase feldspar noted above is probably the only primary constituent which the rock now contains. The rock is probably an altered diabase, which has been subjected to extreme metamorphism.

No. 6. (105a and 105b) Locality, Brownsville, Clay county, Ala.

Chlorite-epidote-schist.—Megascopically, this rock is of a light green color and of fine texture. The mass of the rock is made up of soft green mineral. Small flakes of muscovite are scattered through it.

Microscopic examination shows it to be a fine grained, foliated rock, consisting essentially of quartz, chlorite and epidote. Quartz occurs in lenticular grains which have a wavy extinction. Chlorite occurs in fibrous aggregates, arranged more or less parallelly, giving the rock imperfect cleavage.

Epidote is intimately associated with chlorite as grains and granular masses. Several irregular shaped masses of calcite were observed, and also a little zoisite associated with epidote. The rock also contains considerable muscovite in small plates.

It is interesting to note that section No. 105a contained one irregular mass of magnetite, for there is striking absence of that mineral in most of these rocks.

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